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U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF PUBLICATIONS.

FARMERS' BULLETINS

Nos. 451–475,

WITH CONTENTS AND INDEX.

(136)

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 451.

Experiment Station Work,
LXIII.

Compiled from the Publications of the Agricultural Experiment Stations.

STERILIZING TOBACCO PLANT BEDS.
CLOVER GROWING.
CURING CLOVER HAY.
THE VELVET BEAN.
DRAFT HORSES.
CARE OF MARES AND FOALS.

MARCH, 1911.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

Reprint, December, 1911.

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1911.

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[1] Director. [2] Special agent in charge. [3] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[1]

STERILIZING TOBACCO-SEED BEDS.[2]

Following the successful practice of sterilization of soils for forcing greenhouse crops, the Connecticut State Experiment Station, in cooperation with this department, conducted experiments in sterilizing tobacco beds, the results of which have led several growers to adopt the practice, which has thus been abundantly tested and proved to be practicable and profitable. The practice consists either in steaming the soil sufficiently to kill all foreign seeds and micro-organisms in it to a depth of 2 inches or more, or in treating the beds with formalin for the same purpose.

Beds which have been properly sterilized by steam will need no weeding, as only an occasional weed will show itself before the seedling tobacco plants are pulled. This saving of labor alone pays the cost of sterilizing when the apparatus for it is at hand. The root rot will also be killed and the tobacco thus saved from its attacks. Whether "calico" is lessened by the treatment has not been determined, although our observation this year, to which we refer later, suggested that this might be the case.

It is a matter of common observation, both in greenhouses and in tobacco beds, that the plants in sterilized soil start quicker and grow faster than in untreated soil. This may be in part explained by the warming of the soil, partly by a possible solvent action of the steam or heated moisture on the plant food in the soil, but is no doubt in large part due to a change in the microbe life of the soil effected by the treatment, which may utterly destroy certain kinds of microbes, repress others, and yet leave conditions favorable for the rapid growth later of those species which make available the nitrogen of the soil or otherwise favor the growth of the tobacco plant.

The root rot and some other fungus troubles appear to be completely destroyed by steam sterilization and largely by the formalin treatment.

STEAM STERILIZING.

There are required a portable steam boiler—6 to 8 horsepower—which will maintain a pressure of from 75 to 100 pounds, and steam hose which will stand that pressure, with the necessary connections. The steaming apparatus found most convenient was devised by Mr. A. D. Shamel and is shown in figure 1.

It is a pan 6 by 10 feet square and 6 inches deep, made of 18-gage galvanized iron and having a handle bar at each end. It is reenforced with strap iron to make it more rigid and is fitted with a nipple for the hose connection. The one in use at East Hartford cost $40 and should last 10 years.

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[1] A progress record of experimental inquiries, published without assumption of responsibility by the department for the correctness of the facts and conclusions reported by the stations.

[2] Compiled from Connecticut State Sta. Bul. 166; see also U. S. Dept. Agr., Bureau of Plant Industry Bul. 158, p. 35.

If a sterilizing pan can not be got readily, experience has shown that a tight wooden box of about the same measurement is equally effective, and being a poor conductor of heat probably needs less steam to do the same work.

The bed, having been fertilized, is raked smooth and made ready for sowing. The pan is inverted over one end of the bed and its edges pressed well into the soil. Steam is turned on and kept at a pressure of at least 70 pounds for 30 minutes. * * *

The pan is then moved on, and it is recommended to cover the steamed soil with burlap to hold the heat as long as may be.

Where the beds are many and long, much time can be saved by putting the boiler midway of the bed and using two sterilizers, one at each end of the bed. The steam is turned into the second when the first has been steamed for 30 minutes, and the pan remains there to hold the heat for 25 minutes and is then moved on. * * *

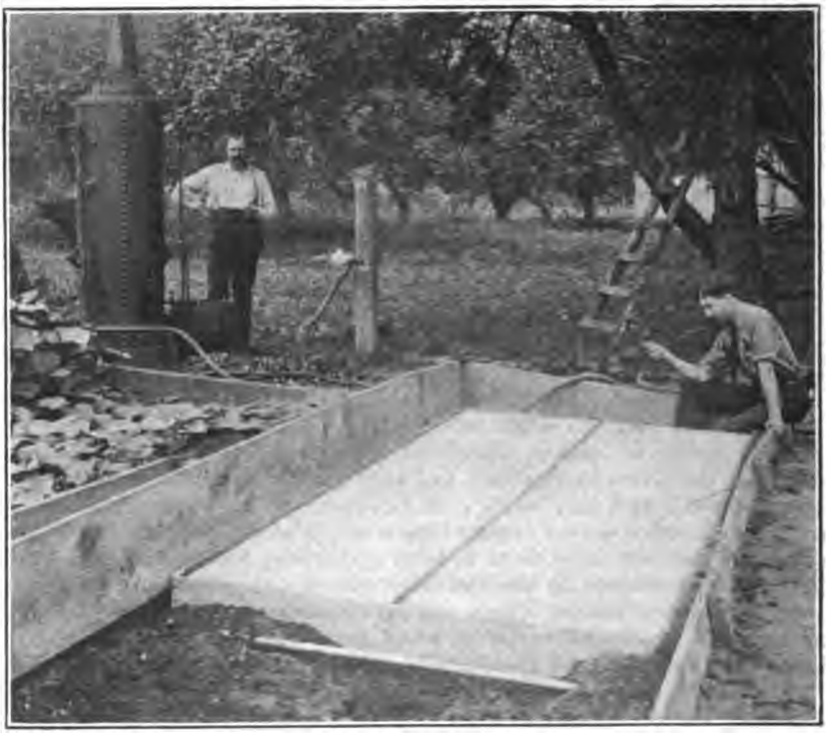

FIG. 1.—Steam sterilizer for tobacco-plant beds.

STERILIZATION WITH FORMALIN OR FORMALDEHYDE.

Steam sterilization is the more convenient where a boiler is near at hand and effective in killing weed seeds, but for small beds and places where the other apparatus can not be got, the formalin treatment can be substituted. It is best applied in the fall and when the soil is comparatively dry. The following method was successfully used by Dr. Clinton of this station in 1907[1]:

A solution of 1 part of formalin—40 per cent strength—in 100 parts of water; that is, a pint of good commercial formaldehyde, also called "formalin," in

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[1] See also method proposed by A. D. Selby in Ohio Sta. Circ. 59.

12½ gallons of water, was gradually sprinkled over the bed at the rate of 1 gallon per square foot, taking care not to puddle the soil. The bed was then covered with burlap or sash to hold in the fumes.

Spring treatment leaves the bed wet and cold and it should not be sown for a week after treatment, lest the formalin still in the soil should kill the sprouting seed. Stirring the soil will facilitate the evaporation of the formalin and excessive moisture.

For further directions regarding the planting of the seed and the subsequent culture of the plants the reader is referred to previous Farmers' Bulletins of the department.[1]

CONDITIONS ESSENTIAL TO CLOVER GROWING.[2]

W. P. Brooks, of the Massachusetts Agricultural Experiment Station, gives the following concise summary of conditions essential to the most successful and profitable growth of clover as brought out by his own experience and observation:

Successful clover growing is impossible unless the soil conditions are right. These plants will thrive upon a considerable variety of soils as regards texture and composition, but for the best results a deep, mellow, and fairly retentive soil which is well drained is essential. Clovers will absolutely fail if there is any considerable proportion of free acid in the soil, or, in farmers' language, if the soil be "sour." If blue litmus paper in contact with moderately moist soil turns red as it absorbs the moisture, this is an indication that the soil is sour; but the farmer will be wise if, before incurring any considerable expense for the correction of acidity, he makes a careful test for himself. One of the best farmer's tests can be carried out as follows: Take two small plats of land in a field supposed to possess "sour" soil, and plow them both. Plats containing about 1 square rod each will be sufficient. They should, of course, be located in a representative portion of the field. After plowing, spread about 20 pounds of builders' lime or agricultural lime on one of the plats. Work this lime in deeply with the wheel harrow, then manure or fertilize both plats alike and heavily, and plant table beets. If the soil is sour, these beets will grow much better on the plat to which the lime has been applied than on the other, and it is safe to conclude that a heavy application of lime will be essential before clovers will flourish. If the experiment indicates that lime is essential, it will probably be needed at about the rate of 1 ton to the acre; the weight referred to to be taken before slacking. If air-slacked lime is used, 1½ tons to the acre will not be too much. The best season for applying lime is autumn or early spring. As a rule, it should be spread upon the plowed land and deeply worked in with the disk harrow.

The writer is aware that splendid clover is often grown where the land is heavily dressed with manure. He is not disposed to deny the possibility of producing fine crops of clover on manure alone. He would, nevertheless, urge that manure alone be not depended upon as a means of enriching clover land. The leading and most valuable element of plant food in manures is nitrogen. The application of this for clovers in any considerable amounts is unnecessary. If clovers are grown on manures, they will feed upon the nitrogen in the manure; they will not draw from the air for that element. Growing clover upon manures, therefore, is not the best economy. Moreover, it is important to point out that the grasses with which clover is most generally grown are greatly invigorated by heavy dressings of manure. A strong, rank growth of the timothy and redtop will tend to crowd out the clover. Fine crops of hay may be produced, but it will not be clover hay, nor rich in clover. The writer would not be understood as urging that manure should never be used on land which is being prepared for clover, although he would strongly advise against top-dressing clover with manure. On soil which is naturally poor in nitrogen, manure may wisely be used in moderate amounts for crops preceding clover. Heavy dressings would be a mistake. It is far better to use the manure in only moderate or small amounts, and to use it in connection with materials which will supply lime, phosphates, and potash.

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[1] U. S. Dept. Agr., Farmers' Buls. 82, 343.

[2] Compiled from Massachusetts Sta. Bul. 134, p. 56.

We should not forget, in considering the best means of growing clover, that the stock of nitrogen in the air from which it is capable of drawing is practically unlimited. The more of this nitrogen we can gather in the crop and in its roots and stubble, the better. In a certain sense, this trapped atmospheric nitrogen is so much clear gain. In considering this point, it must be remembered that the clover plant, like other plants, must take the different food elements in a certain balanced proportion. Though the nitrogen the clovers need is practically unlimited in amount, they can not make a heavy growth unless provided with a great abundance of the elements which they must take from the soil. It is clearly unwise to lessen our chances for gathering the valuable element nitrogen from the air through failure to supply the soil elements in adequate amounts. The rule, then, in preparing for clover or in top-dressing for clover, should be to supply the phosphates, potash salts, lime, and possibly magnesia in great abundance. With these present in abundance, and with a soil of such a character that it will furnish suitable conditions and supply the needed moisture at critical times, enormous crops of clover may be produced.

One of the most important discoveries of recent times is the now generally known fact that the presence of certain bacteria living in symbiotic relations with the clovers and other members of the clover family, and found in nodules on their roots, is essential in order that these plants may draw upon the air for nitrogen. The nodules which in the case of clovers indicate the presence of suitable bacteria are whitish, more or less elliptical bodies, of about the size of the head of a small pin. These grow singly or in small clusters, mainly on the smaller roots. They can be readily found by taking up clover plants grown under proper conditions, with care not to break off too many of the small roots. Bacteria, as is generally understood, are plants. They are very minute. The bacteria themselves are the veriest dust of the dust. As might be supposed, therefore, they appear to be very widely and freely disseminated, and probably through the air. The slightest currents of air must carry them. The dust from a freshly turned clover sod must contain countless millions of them. In certain quarters it has been urged that failures to produce good clover are frequently due to the absence of suitable bacteria, or to their presence in insufficient numbers. Certain experiments with sterilized soils * * * indicate to the writer that clover bacteria are everywhere; and it is not his belief that failures to produce satisfactory crops of clover in this State can often, if indeed they can ever, be attributed to the cause under consideration. The writer has never seen a case where, if a soil be brought into proper condition as to drainage and freedom from acidity, and well stocked with phosphates and potash, clovers have failed to grow; and he has never observed clover plants in any locality and failed to find abundance of nodules on their roots. It is, however, of course a possibility that there may be localities where it will pay to inoculate the soil designed for clover with suitable bacteria. This inoculation may be carried out in either of two ways. First, soil from a locality where clover thrives and where the nodules are known to be abundant may be scattered over the field where the clover is to be sown, and immediately harrowed in. Five or six hundred pounds of such soil per acre will be sufficient. Second, a culture of the proper species of bacteria may be used in accordance with directions which will be furnished with it.

Full directions regarding the inoculation of soils for leguminous plants are given in a previous Farmers' Bulletin of this department.[1]

CURING CLOVER HAY.[2]

In view of the difficulty generally encountered in securing properly cured clover hay, it is believed that the following suggestions on this subject by W. P. Brooks, of the Massachusetts Experiment Station, will be of interest and value to many who are engaged in the growing of clover for hay.

Prof. Brooks points out that the first consideration is the proper degree of maturity of the clover, and states that clover is often allowed to stand too late to give best results when cured as hay.

If it be suffered to remain until a considerable proportion of the heads are brown and the seed ripe, there will be but little rowen, while there is much danger that the roots of the clover will die after the crop is cut. Relatively early cutting, then—before many of the heads are brown—is desirable, both because a better rowen crop will be secured and because the clover will persist in the mowing longer.

Good weather is essential for the satisfactory making of clover hay, as it is, indeed, for the satisfactory making of any hay; but it is far more important in the case of the clovers than for timothy, on account of the fact that the clovers need much more drying. The best hour in the day for cutting, as it appears to me, is late in the afternoon. Whatever the hour, it is essential to keep in mind the fact that in the curing of clover hay it should be handled but little after it begins to dry. It is generally well understood that too much handling as the crop dries results in the breaking off of the leaves and heads, which are the most valuable portion of the crop. Whatever the hour of cutting, then, the fact should be kept in mind that this crop should be tedded but little in curing. If cut late in the afternoon, the crop may be tedded once the following forenoon. If the weather is particularly fine, it will then be ready to rake and put into cocks late in the afternoon of the same day. If the clover is curing more slowly, it may be best to leave it in windrows over one night, and to turn these carefully with the fork the next forenoon, and to cock on the afternoon of the second day after cutting. The use of hay caps in curing clover hay should be more general. It is desirable to leave the clover in the cock for a number of days, sometimes as long as a week. The hay is coarse, and if exposed to rain it is badly damaged unless the cocks are protected by caps. When examination shows that the clover in the cock is apparently cured, it should be slightly opened and turned up from the bottom on the forenoon of a good day. It will then be ready to put in in the afternoon. Clover hay cured in this manner should hold substantially all its leaves and heads, and should cure of a bright-green color. Such clover is one of the most valuable forage crops, whether for cattle, sheep, or horses. Well-cured clover hay, popular opinion to the contrary notwithstanding, is a safe and valuable food for horses, which will need much less grain when fed such hay than when timothy hay is used.

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[1] U. S. Dept. Agr., Farmers' Bul. 315.

[2] Compiled from Massachusetts Sta. Bul. 134, p. 67.

THE VELVET BEAN.[1]

Few crops give satisfactory results for as many purposes as the velvet bean (figs. 2 and 3). Its first use was for the purpose of covering trellises, screens, or unsightly places. Its quick rank growth makes it excellent as a cover crop and for ornamental purposes. This feature makes it objectionable in citrus groves because of the danger that the trees will be completely shaded, or that the vines will interfere with gathering the fruit. In open fields, however, it is not only an excellent cover crop but is very efficient in the eradication of troublesome weeds. Its use for human food is limited.

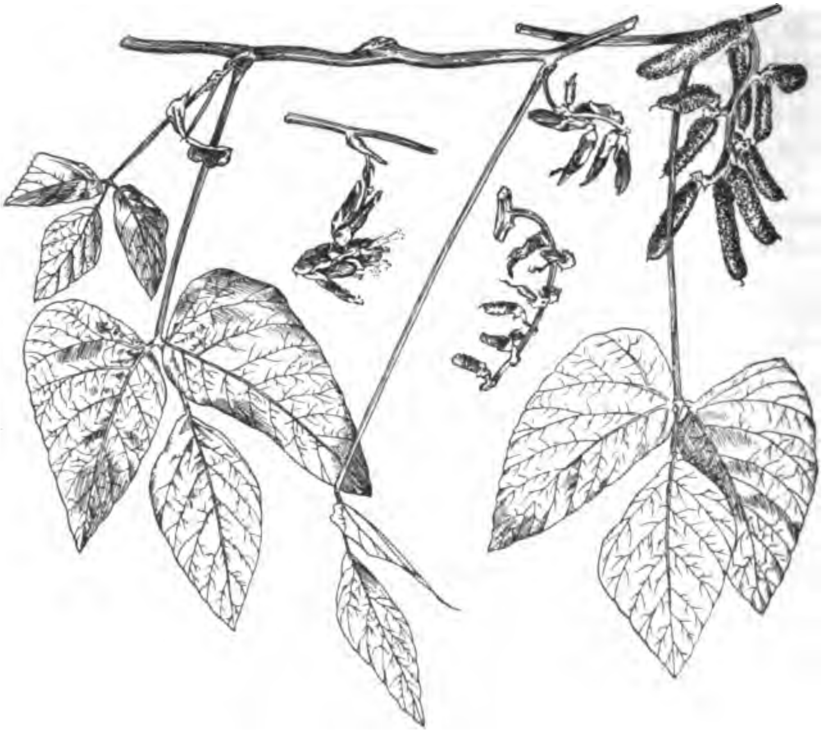

FIG. 2.—Velvet bean, showing leaves, flowers, and young pods.

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[1] Compiled from Alabama College Sta. Bul. 104; Florida Sta. Buls. 60 and 102; North Dakota Sta. Bul. 35; U. S. Dept. Agr., Farmers' Buls. 78, p. 12; 102, p. 41; 300, p. 9; Bur. Plant Indus. Buls. 141, p. 25, and 179; Div. Agrostology Circ. 14.

Like other legumes it is of great importance as a soil improver. The nodules which collect nitrogen from the air vary in size from a mere speck to the size of the pecan. The greater part of the nitrogen, however, is found in the vines, leaves, and seeds. An entire crop

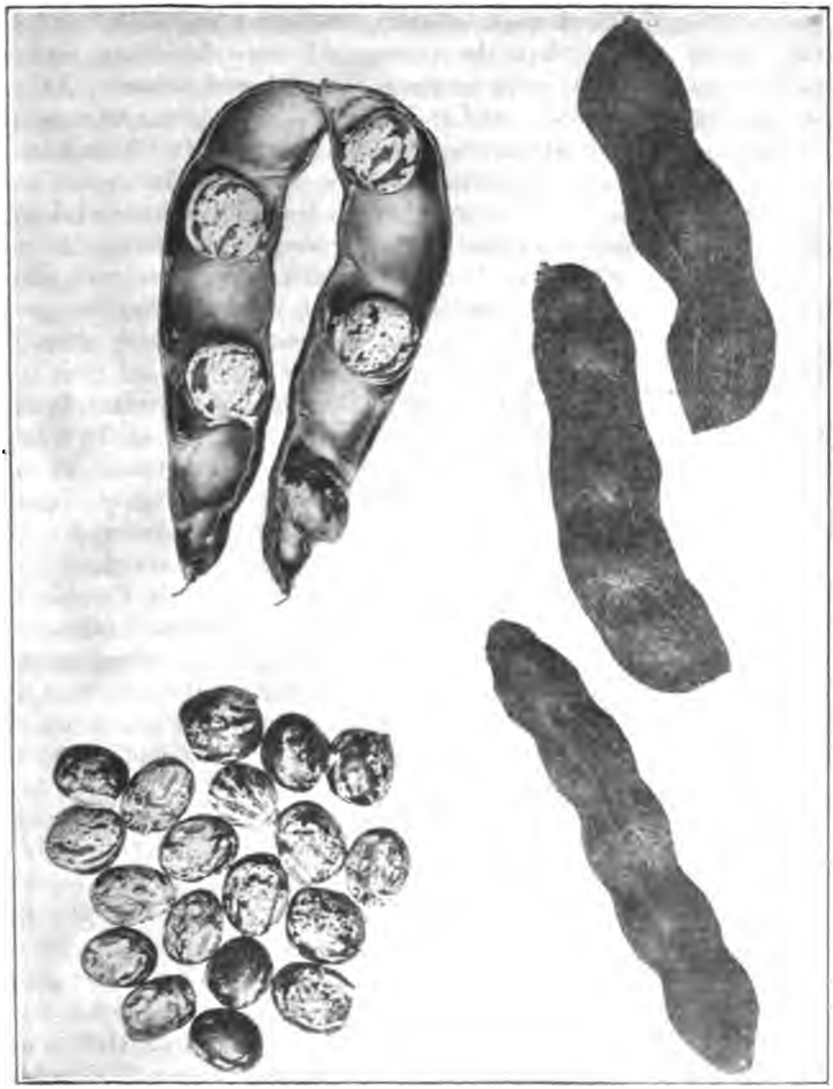

FIG. 3.—Velvet bean, showing mature pods and seeds.

plowed under as a fertilizer has been found to add to each acre ammonia equivalent to that applied in 1,900 pounds of cottonseed meal containing 7.5 per cent of ammonia. A ton of beans in the pod contains 54.8 pounds of nitrogen, 31.8 pounds of potash, and 13.8 pounds of phosphoric acid, having a fertilizing value of $10 or $11. The hulls contain a much higher percentage of phosphoric acid and potash.

In Florida the average of an oat crop produced after velvet bean stubble, and one after the entire crop plowed under was four times as great as the average of crops following crab grass and millet stubble, and slightly greater than the average of crops following cowpea stubble and that following cowpea vines plowed under. At the Alabama Station it was found that the crop of sorghum was nearly doubled as the result of plowing under a crop of velvet beans or of cowpeas. The returns following the two green manure crops were approximately equal. At the same station both velvet beans and cowpeas produced more than four times as much green forage as did German millet. From the Alabama results the cowpea and velvet bean appeared to afford practically equal yields of hay on good land, but on poor, deep, sandy land the velvet bean may afford a larger yield.

The velvet bean is considered especially suited to Florida. It furnishes a better and cheaper source of protein than any other winter forage crop, but does not supply green pasture at any time. It may be pastured from December until the appearance of grass in the spring. As cattle eat only about 50 per cent of the leaves and vines, a large amount of humus is added to the soil for the succeeding crop. It is estimated that an animal will fatten on 1½ acres. In Florida the velvet bean has the advantage of the cowpea in freedom from attack by the nematode which causes root knot. It makes a heavier growth of vines, returning more ammonia and humus to the soil, and the leaves and vines go down to the ground together when killed by frost, while the vines of the cowpea remain upright and allow the wind to scatter the leaves.

These facts probably furnish sufficient explanation for the increase in acreage devoted to velvet beans in Florida—from 10,829 in 1901 to 22,939 in 1907–8. It must be remembered, however, that equally good results can not be obtained in all parts of the country. The velvet bean is a tropical plant requiring about eight months for its maximum growth of vine and production of seed. While it may be grown as far north as the central part of Missouri, it will not yield a profitable crop of seed more than 200 miles north of the Gulf coast. When planted in North Dakota, the beans made a growth of about 18 inches and were in bloom when harvested just before the frosts of early fall. The analysis of the air-dry substance of this crop indicated that the beans were much inferior to peas as nitrogen gatherers in that climate, as the plant contained but 2.57 per cent of nitrogen as compared with 3.6 per cent found in pea plants grown under the same conditions.

The time of planting velvet beans will depend upon the latitude, season, and the purpose for which the crop is grown. In north central Florida, planting for a hay crop may be done any time from May 20 to July 1, but if the crop is to be plowed under the following fall or winter, pastured through the winter, or harvested for seed, the planting should be done not earlier than April 1 nor later than May 1. Such early plantings, however, are likely to result in a tangled growth of coarse, woody vines difficult to harvest for hay and unpalatable to stock. The Florida Station finds that velvet beans planted during the latter half of April will produce three or four times as many beans as those planted after June 20.

Sound seed must be used to secure the largest yield. If the beans are planted in the pod, they may be soaked over night to soften the pods and hasten germination. This method of planting wastes seed, prevents planting by machinery, produces an uneven stand by reason of poor germination, and renders seed selection by means of the fanning mill impossible. Velvet beans may be improved in yield by seed selection. At the Florida Station selected seed produced 33.79 bushels of shelled beans per acre, while the yield from seed just as it came from the huller was 28.37 bushels. This increase in yield made a difference of about $10 per acre in gross income from the crop as a return for the rejection of the small, shriveled, and faulty beans at planting time.

As velvet beans can not be cultivated after the vines have reached any considerable length, preparation of the seed bed should be deep and thorough. In Florida the ground should be plowed to a depth of 6 inches in December or January and harrowed the same day. The use of the harrow should be resorted to at intervals of 10 days throughout the winter until the beans have been planted. The method of plowing just enough to cover the beans and leaving the middles unplowed usually results in the production of about one-half a crop.

If planted alone velvet beans should be 10 to 15 inches apart in the drill, in rows 4 feet apart, or at the rate of about a peck of seed per acre. It is better, however, to plant in rows 6 or 8 feet apart, alternating with rows of corn or sorghum to help support the vines. This method produced a yield of 20.3 bushels of shelled beans per acre at the Florida Station, while the former method produced a yield of 22.5 bushels per acre. The yield of corn "was perhaps 5 to 10 bushels." At the Alabama Station a yield of 7,300 pounds of hay per acre was obtained by planting in drills 2 feet apart, while the best yield obtained by broadcasting was 5,360 pounds. The same method produced the best yield of cowpea hay.

The Florida experiments indicate that the velvet bean is a crop that does not respond economically to the application of any fertilizer on that soil. An increased yield was sometimes obtained, but cost more than it was worth. As with other legumes, however, inoculation may be necessary and may be accomplished by securing from an old cowpea field a quantity of soil about equal in amount to the seed to be planted. Just before planting the seed may be moistened and mixed with the soil. In this way the field is supplied with the micro-organisms necessary for the normal development of the nitrogen-gathering nodules.

When planted in rows, velvet beans should be cultivated until their growth renders further tillage impossible. After this time the vines themselves will smother out all weeds and grass and the roots will obtain abundant plant food if the seed bed has been properly prepared.

The time of harvesting will depend entirely upon the purpose for which the crop has been grown. If used for hay, the crop should be cut just when the young buds are well formed, allowed to wilt about 48 hours, and cured in the shock for several days. To avoid loss through the dropping of leaves, the vines must not become too dry before being placed in the shock. The danger of heating is somewhat less than in case of pea vines, as the beans do not pack together so closely, but the shock should not be too large. If grown as a green manure in Florida, the crop should be plowed under in December in order that the leaves and vines may be well rotted before spring planting begins. If grown for seed, harvesting should not begin until the vines have been killed by frost, but should be completed as early in December or January as possible. If grown as a forage crop, the beans may be left in the field throughout the winter with little loss from decay.

The velvet bean is a highly nitrogenous feed and should not be fed alone, as such feeding has been reported as causing abortion among cattle and hogs and blind staggers in horses. The hay when fed exclusively to horses is likely to cause kidney trouble, but this danger may be overcome by mixture with an equal amount of crabgrass hay. It is also stated that the fat of hogs fed too exclusively on velvet beans is dark in color and offensive in taste and smell.

The velvet bean has but one insect enemy causing serious injury. This is the caterpillar of the moth *Anticarsia gemmatilis*. The crop is not usually attacked until the beans begin to bloom, when the larvæ first eat small holes in the leaves, then as their number and size increase they devour the leaves entirely, leaving nothing but the bare stems of the plants. Blackbirds, ricebirds, and the "green sparrow" render effective service in holding this insect in check, especially the former, when they appear in large flocks. The larger birds are so clumsy that they allow many insects to escape, but the "green sparrow" gets under the vine and picks off numerous caterpillars. The most effective artificial remedy yet discovered is the application of from 1 to 3 pounds of Paris green per acre. The Paris green may be mixed with air-slaked lime in the proportion of 1:3. The mixture may be placed in a bran sack or other loosely woven sack and such sack attached to the ends of a board 6 feet long and balanced on a mule's back. If a boy rides the mule up and down between the rows of beans, the continuous jolting will sprinkle enough Paris green on the foliage to poison the caterpillars. If necessary the boy may strike the board gently with his hand to increase the rate of application. There will be no danger of loss of stock pasturing on velvet beans after such treatment. The amount of Paris green applied is small, and the rains soon wash it off the foliage.[1]

QUALITY AND CONFORMATION OF DRAFT HORSES.[2]

The typical, ideal draft horse, according to A. S. Alexander, of the Wisconsin Experiment Station, stands over 16 hands (5 feet 4 inches) and under 18 hands high, and weighs 1,600 pounds or more in ordinary flesh. (Fig. 4.)

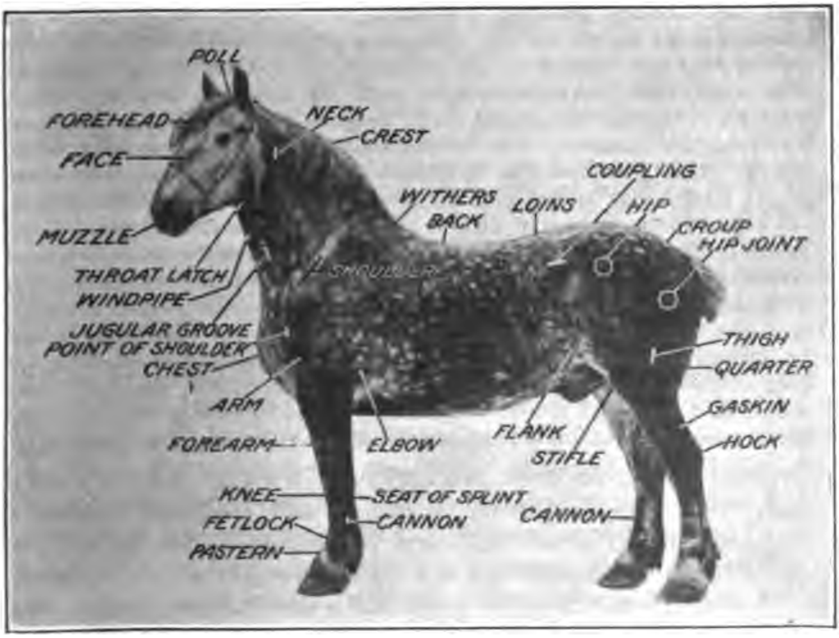

FIG. 4.—A high-grade work horse of fine quality and good conformation, illustrating the "points" of a draft horse.

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[1] For further information on this caterpillar see U. S. Dept. Agr., Bur. Ent. Bul. 54, p. 77.

[2] Compiled from Wisconsin Sta. Circ. Inform. 17. For description of market classes and grades of horses see U. S. Dept. Agr., Farmers' Bul. 334, p. 22.

The form should be broad, deep, massive, evenly proportioned, and symmetrical, the entire make-up suggesting great strength and weight. The body should be massive, blocky, and compact, and squarely set on short, broad, clean, sturdy legs showing fine skin, large joints, and prominent tendons.

Good quality is shown by fine, bright, silky hair; soft, pliable skin; clean, well-defined tendons; smooth, well-developed muscles; strong, smooth bones. It usually is associated with style, spirit, and intelligence indicative of "breeding." * * *

The draft horse should walk spryly, with regular, straight steps and elastic tread. The action when trotting should be free, springy, and straight. * * *

A draft horse does most of his hard work at the walking gait. It is therefore important that he should be able to walk fast without tiring. He should be able to walk 4 miles an hour with a load. To do this the action must be perfectly regular, straight, and level. Joints must be quickly and fully flexed; feet must be advanced and set down without deviation from a straight line. Soles of the feet should turn up and show the shoes plainly as the horse moves away from the observer, at both walk and trot. The feet should be lifted quickly and evenly, and be set down squarely and firmly.

There should be no "paddling," "dishing," or "winging" in or out, cutting or interfering, nor should the fore legs swing out or "roll," or the hind legs be carried too close together or too far apart. In judging of the action the observer must note the movements of each leg and foot, the handling of each joint and the carriage of the entire body, as the horse walks and trots. Watch closely for lameness. The hocks should be carried well together when in motion. Rolling or waddling in front is due to too great width of chest. Knee and hock action should both be free and comparatively high. Perfection of action at the walk is of highest importance in the draft horse.

The draft horse should show a vigorous, lively, energetic disposition, yet be docile, tractable, and intelligent. He should be neither sluggish, nor irritable, nor excessively nervous.

Noticeable vices, as cribbing, wind sucking, weaving, tail switching, shying, biting, kicking, head shaking, etc., are undesirable and a horse showing one or more of these habits should be cut sharply. Sluggishness associated with fat should be avoided, as it induces disease. Stupidity, clumsiness, meanness, or excessive nervousness are objectionable and should discount the animal.

The head should be large, proportionate in size to the body, well formed, clean, and free from coarseness and irregularities. The forehead should be broad, full, and not dished or too prominent. The profile of the face should not be too straight or of "Roman-nose" form. There should be good width and fullness between the eyes, indicating power and intelligence. The eyes should be bright, clear, mild, full, sound, and of the same color. The lids should be smooth, well arched, and free from angularities and wrinkles. The ears should be of medium size, well placed, alert, normally active, and free from coarseness. The nostrils should be large and flexible; the lips thin, even, and firm, and all of the parts neat and clean cut. The skin and hair of the muzzle should be of good quality. There should be a wide space between the lower jaws free from meatiness, abscesses, or tumors. The neck should be of a size proportionate to the rest of the body, well arched, evenly muscled, with large windpipe and smooth insertion into the shoulder. It should not curve downward (ewe neck) or be broken in crest.

It should fit neatly into the head and be free from thickness, coarseness, and enlargements at the throat latch. The neck should merge evenly and smoothly into the withers and shoulders and be free from sores at the seat of the collar. The mane should be thick, lie properly and of good quality. Largeness of the windpipe indicates good breathing powers. The jugular vein should show no scars of bleeding and the glands about the throat should be clean and of normal size.

The shoulder should be moderately sloping, smooth, and extending well back.

A majority of poorly formed draft horses have shoulders which are too steep. Occasionally the shoulders are too sloping. Either extreme in a draft horse is objectionable. Trouble with collars comes from these causes when the horse is doing heavy pulling. The correctly laid shoulder should form a smooth, comfortable bed for the collar. Straight or upright shoulders detract from easy, free action of the forelegs and generally are found associated with upright pasterns. The shoulders should be smoothly and deeply covered with muscles and be free from coarseness, roughness, sores, and tumors. The withers should be well covered and moderately high.

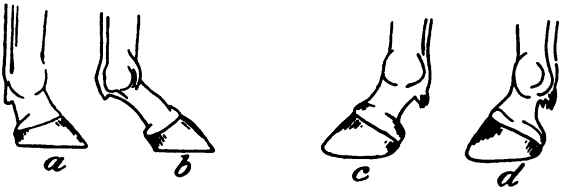

FIG. 5.—Correct and incorrect types of pasterns and feet: *a*, Pastern too straight and upright; *b*, pastern too sloping; *c*, correct type of forefoot; *d*, correct type of hind foot.

The arm, which extends from the point of the shoulder to the elbow, should be short, heavily muscled, and well thrown back. The forearm, extending from the elbow to the knee, should be long, flat, wide, heavily muscled, and free from coarseness. The knees should be straight, wide, deep, strongly formed, and smooth. The cannons, extending from the knees to the fetlocks, and composed chiefly of bones and tendons, should be short, strong, clean, and wide, with prominent and smooth tendons. The fetlocks should be wide, straight, strong, and free from puffs, callouses, or interfering sores. The pasterns, extending from the fetlocks to the hoof heads, should be moderately sloping, strong, and clean. (Fig. 5.)

The tendency in the average draft horse is toward short, upright pasterns and stubby gait. This is highly objectionable as are also very long, weak pasterns, which bring the back of the fetlocks too close to the ground. The latter cause strain upon the tendons when drawing heavy loads. The short upright pasterns are even more objectionable since they prevent springy, elastic action of the feet and allow concussion to jar the bony columns of the legs. The irri-

tation and inflammation induced by continued jarring often results in sidebones, ringbones, corns, and kindred diseases. The bone of the pastern should have a slope of about 45° and the front of the foot 50°. Horses having upright pasterns and consequent stubby action wear out quickly when used upon paved streets.

The hoofs should be ample in size, sound, smooth, and symmetrical in shape.

The hoof is a continuation of the skin of the parts above. The color of the skin decides the color of the hoof. Dark-colored hoofs are preferred. Color counts for little, however, if the hoofs are of poor shape and texture. The horn should be smooth, waxy looking and free from cracks or ridges and the coronets (hoof heads) should be open, prominent and wide at the heels. The sole should be slightly cupped (concave), not flat, or bulging (convex); the frog large, elastic, healthy, and without a deep cleft; the bars prominent.

The chest, inclosing the heart and lungs, should be roomy in every respect. "An ample, wide, deep chest denotes vigor, power, strong constitution, and easy keeping qualities." The ribs form the "barrel" and should be deep, well sprung, and carried low at the flanks and close to the hips. The back, extending from the rear of the withers to the last rib, should be broad, straight, and muscular. In general appearance it should denote great strength and compactness. The loins should be short, wide, deep, and strong. The underline should run back full and low from the floor (sternum) of the chest. "If the underline slopes sharply upward to the stifle the abdomen has a cut-up appearance. This indicates lack of roominess and denotes poor keeping qualities."

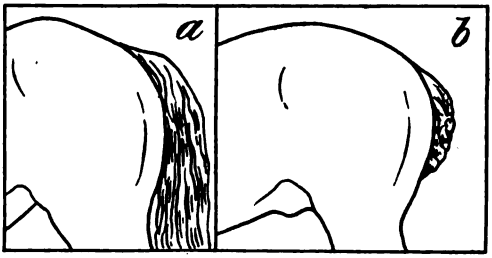

Fig. 6.—Good and poor form in croup and hips: *a*, Too short and steep; *b*, good draft type.

The upper part of the hind quarter should show great development of wide, thick, smooth muscle without angularities and coarseness. The croup, the part of the hind quarter from top of the hip to the insertion of the tail, should show comparative levelness, ample muscle, and great strength. (Fig. 6.)

The most notable deficiency of this part in draft horses is excessive droop, or steepness and shortness, with weakness of muscle. Such conformation tends to slouchiness in gait and often is associated with "sickle" hocks. The draft croup should be smooth, of fair length, and neither too steep nor perfectly level.

The thighs from the hips down to the stifles should be strong, muscular, wide, and long.

Slim, light, narrow, poorly muscled thighs denote lack of draft power. It is important that the thighs and all other parts of the hind quarters should be richly supplied with muscles.

Looking from the rear the plump muscles of the inner sides of the thighs form the quarters and should be full, thick, and carried well down to the second thighs (gaskins).

The stifle joints should be strong, thick with muscle, clean-cut in front, and free from dropsical swellings.

Like the elbows, they should be so set as to allow of straight, free action, and therefore neither appreciably turned toward or away from the body.

The gaskins, or lower thighs, correspond to the forearms, and should have the same qualities; the muscles should be large, prominent in front of the bone, and carried well downward. The hocks are most important joints because the great strain of starting and hauling a load falls upon them, and they will soon break down if not very strong and perfectly sound. The joints should be large, clean, sharply defined, wide, deep, and well set.

Poor hocks are a common fault in draft horses. It is important to improve this deficiency. To that end breeding animals should have good hocks, and for work horses this also is imperative. The hock (not "hind knee") is commonly the seat of some one of such diseases as bone and bog (not "blood") spavin, thoroughpin, and curb. These should be avoided. The joint should lock and feel firm, hard, and with each bone well defined, free from meatiness and of great size. The point of the hock should be prominent, clean, and sharp, and the tendons under it straight, distinct, but free from bulging.

What has been said regarding cannons, fetlocks, pasterns, and feet of the foreleg applies with equal truth to the corresponding parts of the hind extremity.

The cannons of the hind leg should have the same wide, flat appearance desirable in those of the foreleg. As the hind feet strike the ground a slanting blow, while concussion on the forefeet is direct, absolute correctness in form and perfect soundness is somewhat more important in the forefeet than in the hind feet. The hind pasterns may be slightly more upright than those of the foreleg. The hoofs of the hind limbs are steeper and narrower than those of the forelegs. The hind fetlocks are most likely to be blemished by puffs and interfering sores.

CARE OF BROOD MARES AND NEWBORN FOALS.[1]

The loss of foals before weaning time has been variously estimated at from 10 to 25 per cent. According to Dr. A. S. Alexander, of the Wisconsin Experiment Station, the greater part of this loss can be avoided if proper attention is given to the pregnant mare and to the foal during the first few weeks of its existence.

MANAGEMENT OF THE PREGNANT MARES.

Many brood mares are overworked and others are kept too closely confined in stables. Both stallions and mares should be moderately worked and kept in the open as much as possible. If kept in a stable, the latter should be well ventilated, and much of the time the mare should be in an open shed. Good pasture grass is the best feed. Corn should not be fed except in small quantities.

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[1] Compiled from Wisconsin Sta. Circ. Inform. 13.

The mare in foal should be worked lightly or abundantly exercised every day. Exercise is absolutely necessary. She should occupy a roomy box stall. Here she will take some additional exercise and will not be afraid to lie down. She will be less likely to become "cast" and escape having "stocked" legs and dropsical swellings of the udder and abdomen. The bedding should be kept clean and dry.

Feed the mare sound, whole oats, bran, and mixed or timothy hay. Avoid moldy hay or silage, damaged grain, woody, weathered fodder, dusty or rusty straw, or hay containing ergot. Keep pregnant mares out of cornstalk fields. Provide them with plenty of pure, clean water. In working mares avoid jerking, severe pulling, wading through deep mud, manure piles, or snowdrifts. Let the work be light, easy, and steady. Keep the bowels active by feeding bran and a little flaxseed meal, carrots, or some sweet silage.

The mare goes 48 weeks, or about 340 days with foal. As foaling time approaches decrease the grain ration and increase laxative foods to keep the bowels acting freely. Constipation is dangerous. When wax forms on the teats, about three days before foaling, stop working the mare and place her in a prepared box stall where she can be watched until the foal is born.

After foaling leave the mare alone for a time, if she is lying down. If she does not expel her afterbirth promptly when she rises from resting, inject into her womb one-half gallon of lukewarm 1 per cent solution of coal-tar disinfectant, or other mild antiseptic. If the afterbirth then does not come away within an hour or two, it should be removed by hand. An expert should be employed for this operation and when it has been performed the womb should again be flushed out with an antiseptic solution. Half an hour after the birth of the foal, or about that time, offer the mare a pailful of lukewarm water and again at intervals of two hours. Mares are thirsty at this time and should be abundantly supplied with water. An hour after foaling the mare may eat a mash of steamed oats and bran, if she has been accustomed to such feed; otherwise give her a small feed of her ordinary grain ration. In a few days, if the weather is fine, the mare and foal may take some outdoor exercise, and in two weeks, or thereabouts, she should have recovered from foaling and be taking her usual feed, grazing grass and getting ready to resume light work in harness.

Two 14 by 14 foot box stalls should be kept ready for the use of mares on every farm where foals are raised. No mare should be allowed to foal in an ordinary stall or unprepared box stall. Navel and joint diseases will not be likely to attack foals born in clean places. An absolutely clean foaling place is necessary and should be prepared as follows:

Remove and burn all loose litter and manure. Cleanse and scrape the floor; then saturate it with a hot 1 to 50 solution of coal-tar disinfectant or a solution of 4 ounces of sulphate of copper (bluestone) to 1 gallon of hot water. Scrub and cleanse the walls with a similar solution of coal-tar disinfectant or a 1 to 1,000 solution of corrosive sublimate. Cleanse the ceiling in the same way; then apply to walls and ceiling fresh-made lime whitewash, to each gallon of which has been added one-third of a pound of chlorid of lime. Cover the floor with fresh, dry planing-mill shavings in preference to any other bedding material. Remove manure as soon as it is dropped.

CARE OF THE NEWBORN FOAL.

When the foal is born and has been cared for and the afterbirth of the mare has come away, remove the mare and foal to the second box stall, prepared as was the first. Then clean out, disinfect, and whitewash the stall just used and put in fresh, clean, dry shavings, in readiness for the reception of the next mare. The mare must always occupy a clean, specially prepared box stall, and it should be perfectly ventilated and as sunny as possible.

Where but one box stall is available clean it out, burn the afterbirth and soiled bedding, use a disinfecting solution freely on the floor, and put in plenty of fresh, dry, clean shavings as soon as possible after the birth of the foal. If the mare foals on grass, treat the foal as if it had been born in the stable. Navel infection is less liable to occur on grass, but this is possible, and preventive treatment therefore is necessary, no matter where the foal is dropped.

Attend to the navel cord (umbilicus) as soon as the nose of the foal has been cleared of afterbirth. If possible, avoid tying the navel cord. It is best for it to break off naturally. If it fails to break and the mare is lying down, make her get up, and the cord may then break.

If found necessary to tie the cord, use a clean disinfected string. A dirty string may cause infection. Soak the string in a 5 per cent solution of lysol or carbolic acid or a 1 to 500 solution of corrosive sublimate (bichlorid of mercury). Tie the cord 1 inch or a little more from the belly; then sever the cord with a clean knife. An emasculator or ecaseur (castrating instruments) may be used to sever the cord in place of tying it and then cutting through below the knot.

Saturate the stump of the navel cord immediately, whether tied or not, with the following disinfectant: Powdered corrosive sublimate, 2 drams; boiling water, 1 pint. When it has cooled, color the solution with 2 drams of tincture of iron, label the bottle "poison," and keep it out of the way of children. Repeat the application twice a day until the cord shrivels up, drops off, and no raw spot remains. To keep the solution from blistering the foal's belly, smear carbolized vaseline or unsalted lard around the navel before making the first application.

A good way to use the solution is to put some of it in a shallow, wide-necked bottle, then hold the bottle against the foal's belly with the navel stump immersed so that it will be completely covered by the fluid. If the navel cord has been tied, remove the string as soon as possible, squeeze out the blood clot, and instantly soak the navel stump with the corrosive sublimate solution. Use the solution twice a day until the navel is perfectly healed. Remove sloughing portions of the cord each morning, so far as possible, to allow the solution to wet raw parts of the cord.

A strong foal will be on its feet and trying to nurse in less than an hour from birth. Such a foal needs no help, but a weak one will have to be held up to suck until strong enough to do so without help. Wash the udder of the mare with a lukewarm 2 per cent solution of coal-tar disinfectant and then rinse off with warm water before the foal is allowed to suck for the first time. The external organs (genitals), tail, and hind parts of the mare should be washed with a similar solution once a day for the first week or so after the birth of the foal.

Keeping the udder free from infective matter in this way tends to prevent the foal from scouring, for that condition of the bowels often is due to germ infection of the intestinal tract by way of the mouth. Disinfection of the navel cord also tends to prevent scouring. At birth the intestine of the foal contains a sticky mass of fecal matter (meconium). This should come away promptly and usually this is accomplished by the first milk (colostrum), which possesses purgative properties. To assist nature, either insert a small tallow dip candle (made for this purpose) in the foal's rectum, or within an hour from birth give an injection of either warm water, warm slippery elm bark tea, flaxseed tea, sweet oil, or a mixture of equal parts of cream, molasses, and warm water, and repeat in 12 hours if required. Harm may be done by injecting a large quantity of strong, soapy warm water with an ordinary "horse syringe." A fountain syringe is to be preferred and small hard-rubber nozzle or a small clean rubber hose and funnel. Smear vaseline or lard on the nozzle and in rectum before giving the injection. If the bowels do not move within 24 hours from birth and the foal seems sick, shake up two to four tablespoonfuls of pure castor oil in milk or a mixture of equal quantities of castor oil and sweet oil, according to size of foal, and give as one dose. Then continue the injections at intervals of six hours.

In case the mare dies or has no milk the foal may be raised on cow's milk, if the attendant conducts the work patiently and intelligently. Choose the milk of a cow that has recently calved, preferably one which gives milk low in butterfat, for mare's milk, while rich in sugar, is poor in fat. Sweeten the milk with molasses or sugar and dilute with warm water. Give a little of this prepared milk at short intervals from a scalded nursing bottle and large rubber nipple. Be careful to keep the bottle and nipple scrupulously clean. Add an ounce of limewater to each pint of the prepared milk and allow half a cupful once an hour at first.

As the foal grows, gradually increase the amount of milk fed and lengthen the intervals between meals. In a few days food may be given six times a day, and later four times daily. The foal will soon learn to drink from a pail if allowed to suck the attendant's fingers at first.

Until the bowels move freely give rectal injections night and morning. If the foal scours at any time, give two to four tablespoonfuls of a mixture of sweet oil and pure castor oil shaken up in milk and stop feeding milk for two or three meals, allowing sweetened warm water and limewater instead. Let the foal lick oatmeal as soon as it will eat and gradually increase the amount and add wheat bran. In five or six weeks some sweet skim milk may be given and the amount gradually increased daily until, in three months or so, it may be given freely three times a day in place of new milk. The foal at this age also will be eating freely of grass, grain, and bran.

At all times supply pure cold drinking water. Let the foal run out in a lot or grass paddock for exercise. Accustom it to be handled daily. Feed small quantities of nutritious food often, keeping all food vessels clean, and the foal should thrive and develop well.

NAVEL AND JOINT DISEASE IN THE NEWBORN FOAL.

Seventy-five per cent of the cases of this disease affect foals during the first three weeks of life. Fat, flabby foals, with extra large navel cords, often the get of overfed, pampered, underexercised stallions, or from mares in like condition—are especially prone to the disease and are most likely to succumb. Foals that have small navel cords and are lively at birth, soon on their feet and nursing, are much less liable to attack.

Dr. Alexander describes the symptoms of navel and joint disease as follows:

> A few days after birth the foal is found to be weak, lame, feverish, and with impaired appetite. One joint or another is swollen, hot, and painful. Usually the attack affects the fetlock, hock, stifle, hip, knee, elbow, or shoulder. Sometimes abscesses form at the poll, about the ribs, or along the spinal column. The swellings rapidly increase in size and several joints are affected at one time. There is swelling of the navel, and pus oozes from one or more openings. Pus forms in quantities in the affected joints. Diarrhea usually comes on, or may be alternated with constipation. Soon the foal is too weak to stand, loses appetite entirely, and dies in a few days, or in two or three weeks, in lingering cases. Often urine escapes from the navel, or the foal passes bloody urine; but the latter symptoms may, for a time at least, be present without noticeable symptoms of pus infection.
>
> The navel cord (umbilicus) connects the foal's body with the afterbirth (placental membranes) of the mare. * * *
>
> When the navel cord breaks at birth its blood vessels and tube promptly close, if all goes well. If pus-forming germs from filthy or soiled bedding, floor, or ground, get onto the raw navel cord, however, they cause infection, inflammation, and collections of pus at the point involved, and thence germs are carried into the system and form colonies (secondary abscesses) elsewhere in the body. and notably in the joints of the extremities.
>
> In cases of generalized infection (pyæmia) abscesses may be found in the liver, kidneys, lungs, brain, muscles, and subcutaneous connective tissue. If the urachus fails to close, urine dribbles or streams from the navel opening and, in that event, abscesses of the joints eventually appear, the infection having become general. The latter condition is termed "pervious" or "persistent" urachus. A majority of infected foals die. Recovery is seldom perfect. The colts fail to thrive or develop perfectly, and are apt to have chronic affections of the joints. Treatment of the disease can only be properly conducted by the trained veterinarian, and he may employ a special (antistreptococcic) serum with some degree of success, both as a preventive and curative agent.

When working the mare the foal should be left in the stall. He will fret at first, but gradually gets accustomed to being alone. For the first few days the mare should be worked only half a day. She will be soft and worry greatly, probably heating herself up quite badly, in which case it is a good plan to milk her almost dry on coming in at noon and then put her in a stall to eat a little hay until she cools off. After this she may be watered, turned in the stall with the foal, and fed her grain. Beginning with a half day in this fashion she may be gradually toughened back into doing her full share of the regular team work. The foal should never be allowed to suck milk from a worn mare, as it sets up indigestion and starts scours. A bucket of water should be kept in the stall so the foal may take a drink whenever he wants it.

A foal will begin to nibble at grain when he is about a month old, sometimes earlier. His first food should be oatmeal, allowing him such small quantities of this as he will eat. At six weeks of age a little bran may be added, to be followed later with grain. Grass should be supplied as soon as the foal wants it. When feeding bran or grain the supply should be renewed often so as to keep it fresh and sweet and any sudden changes in feeds must be avoided. If foals are thus cared for during the summer the weaning process is an easy one. When weaning the foal he should be kept away from his dam for good. Weanlings should have warm quarters during the first winter, and may be fed good oats and bran—one-fifth bran by weight—and choice hay free from dust and mold, the feed to be given often and a little at a time.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 452.

CAPONS AND CAPONIZING.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., March 8, 1911.

SIR: In the Twenty-second Annual Report of this Bureau there appeared a paper on "Capons and Caponizing," by Mr. Rob R. Slocum, which was reprinted in pamphlet form as Circular 107 of this Bureau. As the supply of that circular is exhausted, and as there is a continued demand for information on the subject, I have the honor to recommend that a revised edition, the manuscript for which is herewith transmitted, be published as a Farmers' Bulletin.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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CAPONS AND CAPONIZING.

HISTORICAL SKETCH.

It is impossible to say just how long the operation of caponizing has been performed. It seems quite certain, however, that the practice was familiar to the Chinese more than two thousand years ago. Later it was practiced by the Greeks and Romans and, through medieval times, by the people of middle and southern Europe, until in recent times it has been introduced into America. At present capons are most universally known and appreciated in France, although within the last few years the business of producing them has advanced rapidly in this country. Much the larger part of the industry is confined to that portion of the United States east of Philadelphia, though increasing numbers of capons are being raised in the North Central States. During the winter months capon is regularly quoted in the markets of the larger eastern cities. Massachusetts and New Jersey are the great centers for the growing of capons, while Boston, New York, and Philadelphia are the important markets.

DESCRIPTION AND CHARACTERISTICS OF THE CAPON.

What is a capon? A capon is an altered or castrated male chicken, bearing the same relation to a cockerel that a steer does to a bull, a barrow to a boar, or a wether to a ram. As with other male animals so altered, the disposition of the capon differs materially from that of the cockerel. He no longer shows any disposition to fight, is much more quiet and sluggish, and is more docile and easy to keep within bounds. The true capon never crows. Along with this change in disposition there is a change in appearance. The comb and wattles cease growing, which causes the head to appear small. The hackle and saddle feathers develop beautifully. Indeed, these feathers and the undeveloped comb and wattles serve to identify the capon and in consequence should never be removed when the bird is dressed for the market.

As a result of the more peaceful disposition of the capon he continues to grow and his body develops more uniformly and to a somewhat greater size than is the case with a cockerel of the same age.

For a time the cockerel and the capon make about equal development; but as soon as the reproductive organs of the cockerel begin to develop the capon begins to outstrip him in growth. Also when finishing off the capon fattens more readily and economically. As they do not interfere with or worry one another, a large flock of capons may be kept together. Coupled with the better growth is the fact that the capon brings a better price per pound. Cockerels up to 5 months old usually bring from 12 to 18 cents a pound; if held longer than this they become "staggy," are classed as old cocks, and do not bring more than 6 to 12 cents a pound. Capon in season brings 18 to 25 cents and often more a pound. There are two reasons, then, why it is better to caponize surplus cockerels than to raise them for market as such: (1) There is an increase in weight, and (2) the price per pound is materially increased. Yet in many localities where especially fine poultry is raised, while capons usually sell for a somewhat better price, the difference is not great. In fact, for the Boston market many capons are picked clean and sold as "south shore roasters." Hence it will be seen that the profit in capons must depend to a great extent upon local conditions. The demand for capons continues good, notwithstanding the fact that more and more are raised each year.

SELECTION OF BREEDS.

In selecting the breed best suited for caponizing, several factors must be taken into consideration. Large capons bring the best prices. Consequently the breed should be large. It does not pay to caponize small fowls. Yellow legs and skin, as in other classes of poultry, are most popular. The Plymouth Rocks, Light Brahmas, Cochins, Indian Games, Langshans, and Wyandottes are all recommended by different producers, as are also various crosses of these. The Brahmas and Cochins possess good size. By some the Brahmas are claimed to be difficult to operate upon; by others this is denied. The Plymouth Rocks and Wyandottes are somewhat smaller, but sell readily and possess the advantage of yellow skin and legs. The Langshan is large and is easily operated upon. The Indian Game is probably most useful as a cross upon some one of the other breeds, thereby improving the breast meat without materially reducing the size of the fowl. In Massachusetts the Brahma was formerly the most popular breed for this purpose, because of the demand for large birds for roasters. Later, crosses between the Light Brahma and the Barred or White Plymouth Rock became quite popular, while at present the pure Barred and White Plymouth Rocks are also considered suitable and are widely used.

TIME TO CAPONIZE.

In so far as the effects of the operation and the rapidity and ease of healing are concerned, the time of year when the operation is performed is of little importance. The capons seem to recover and do well at any time. Certain other considerations, however, do influence the time. The age and size of the cockerel are very important. As soon as the cockerels weigh 2 to 3 pounds, or when 2 to 4 months old, they should be operated upon. The lower age and weight limits apply particularly to the American breeds, while the higher apply to the Asiatics. If smaller than this, their bodies do not give room enough to work handily. On the other hand, they should never be over 6 months old, as by this time the testicles have developed to a considerable extent, the spermatic arteries carry greater amounts of blood, and the danger of pricking these arteries and causing the fowl to bleed to death is greatly increased. The fact that capons are in greatest demand and bring the best prices from the Christmas season until the end of March, and that it takes about 10 months to grow and finish them properly, makes it important to hatch the chicks in early spring so that they will be of proper size for caponizing in June, July, and August. These are by far the most popular months for the operation, though in some cases it is performed still later.

CAPONIZING INSTRUMENTS.

There are several sets of instruments for performing the operation. These differ principally in the type of instrument used in getting hold of and removing the testicle. One type is the cannula (fig. 1, *a*). This consists of a hollow tube, the lower end of which is compressed and closed except for two small holes through which to run the horse hair or wire comprising the other part of the instrument. This type is very satisfactory but requires two hands to operate. Another type is the twisting scoop (fig. 1, *b*). This is a spoon-like scoop slotted in the center and mounted upon a slender rod. It is designed to slip under the testicle, allowing the spermatic cord to pass through the slot. By twisting the cord is severed. This type has the advantage of requiring only one hand to operate, but is more liable to produce slips than the cannula. A third style of instrument, (fig. 1, *i*) is also in the form of a spoon or scoop, but instead of being in one piece has two jaws regulated by a slide. The testicle is caught in the scoop with the spermatic cord between the jaws, and by tightening the jaws and gently moving the instrument the cord is severed and the testicle removed. Still another type, not now in common use, is the spoon forceps. With this the testicle is simply grasped with the forceps and detached by a twisting movement. Here one hand can be used also, but the liability of slips is rather greater than with the other methods.

Figure 1, *k*, shows a type of forceps, consisting of two hinged arms, one of which terminates in a broad, flat surface, and the other in an end of similar shape from which the center has been removed, leaving only a narrow rim. These two ends are held closely pressed together by means of a rubber band passing across the handles. In use, the ends of the forceps are separated, the solid one slipped under the testicle and the rim then allowed to settle down over it. The

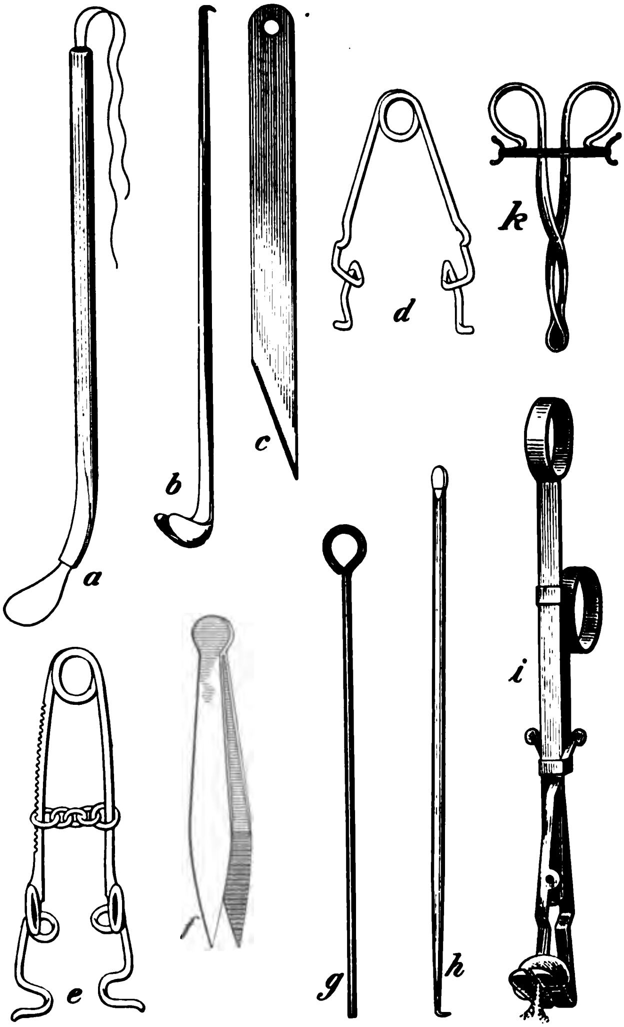

FIG. 1.—Instruments used in caponizing.

cord is then caught and the testicle can be removed. Careless or too rapid use of this instrument is likely to cause slips. A knife for making the incision into the body cavity is of course necessary. Almost any sharp-pointed, thin-bladed knife will answer the purpose well (see fig. 1, *c*). Some sort of spreader to spring apart the ribs far enough to allow the instruments to be inserted into the body must be used. A plain spring spreader, as shown in figure 1, *d*, or a sliding spreader (fig. 1, *e*), allowing the pressure to be gauged, will answer the purpose. A sharp-pointed hook (fig. 1, *h*), for tearing away the thin membranes, and a blunt probe, of which figure 1, *g*, is one type, for pushing aside the intestines, complete the necessary equipment. A pair of small tweezers or nippers (fig. 1, *f*), is also useful in removing any foreign matter from the body.

THE OPERATION OF CAPONIZING.

Before beginning the operation two conditions are absolutely essential. If these are not favorable, do not attempt to operate. The first of these is that the intestines of the fowl should be completely empty, so that they will fall away and expose the testicle to view. This can be accomplished by shutting up the fowls and withholding all food and water for twenty-four to thirty-six hours before the operation. Thirty-six hours is better than twenty-four, especially for a beginner. The second condition is a good, strong light, so that the organs of the fowl may be clearly and easily distinguished. Direct sunlight is best for this, and in consequence it is well to operate out of doors on a bright day. Some operators have substituted the physician's head reflector and artificial light with good success. It has been suggested that a probe consisting of a small electric bulb on the end of a slender rod and operated by small dry batteries, so that it can be introduced into the body cavity, could be manufactured and used with good success.

METHODS OF HOLDING THE FOWL.

When ready to operate, catch the bird and pass a noose of strong string about the legs. Do the same with both wings close to the shoulder joints. To the other end of the strings are attached weights of sufficient size to hold down and stretch out the bird when placed upon the head of a barrel or box of convenient height, which is to serve as operating table. These weights are allowed to hang on opposite sides of the barrel or box (see fig. 2). A table, if so desired, may be arranged by boring holes through its top at proper distances from each other, allowing the strings to pass through these, and hanging the weights underneath. Still other ways of holding the fowl in place have been devised, but these are unimportant so long as the fowl is held securely stretched out.

DETAILS OF THE OPERATION.

Having fastened the fowl, be sure that all the instruments are at hand. It is also well, though not necessary, to have ready some absorbent cotton and a dish of water to which has been added a few drops of carbolic acid. Having once started, carry the operation through as quickly as possible. Moisten and remove the feathers from a small area over the last two ribs just in front of the thigh (see fig. 3). With the left hand slide the skin and flesh down toward the thigh. Holding it thus, make the incision between the last two ribs (fig. 4), holding the edge of the knife away from you as you stand back of the fowl. Lengthen the incision in each direction until it is 1 to 1½ inches long. Now insert the spreader into the incision, thus springing the ribs apart, as shown in figure 2. The intestines will now be visible, covered by a thin membrane called the omentum. Tear apart this membrane with the hook, and the upper testicle, yellow or sometimes rather dark colored and about the size and shape of an ordinary bean, should be visible close up against the backbone. By pushing aside the intestines this can easily be seen, and the lower one also, in a similar position on the other side of the backbone. Expert operators usually remove both testicles through one incision. This is a desirable practice, as it saves time and is not so hard on the bird. Inexperienced operators will usually find it well to attempt the removal of the upper or nearer testicle only and to make a second incision on the opposite side of the body for the removal of the other testicle.

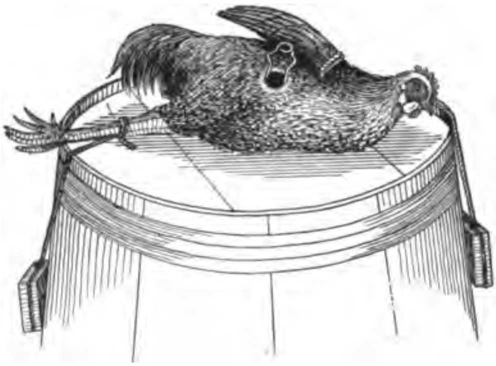
FIG. 2.—Method of securing fowl; also spreader in place.

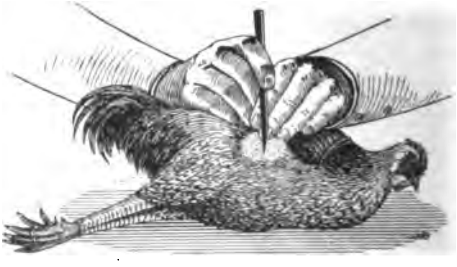
FIG. 3.—Ready to make the incision.

If both testicles are to be removed through the same incision, remove the lower first, as the bleeding from the upper might be sufficient to obscure the lower. Each testicle is enveloped in a thin membrane. This may be and probably is best removed with the testicle, though some operators tear it open and remove the testicle only.

The delicate part of the operation is now at hand, due to the close proximity of the spermatic artery, which runs just back of the testicle and to which the testicle is in part attached. If this is ruptured the fowl will bleed to death. The cannula, threaded with a coarse horsehair or fine wire, or one of the other forms of instrument previously described, now comes into use. If the cannula is used, allow the hair or wire protruding from the end to form a small loop just large enough to slip over the testicle, as shown in figure 5. Work this over the testicle, being careful to inclose the entire organ. Now tighten up on the free ends of the hair or wire, being careful not to catch any part of the artery. If the spermatic cord does not separate, saw lightly with the hair or wire. When the testicle is free, remove it from the body. If only the upper testicle has been removed, turn the bird over and proceed in exactly the same manner upon the other side.

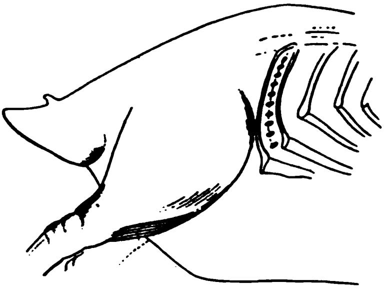
FIG. 4.—Diagram showing where incision should be made between last two ribs.

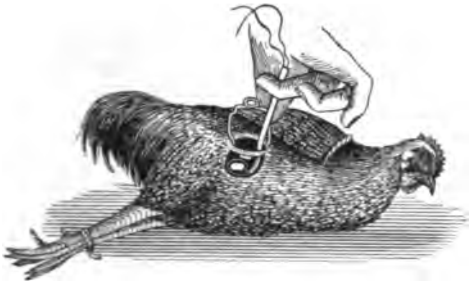
FIG. 5.—Cannula in use. (The lower aperture appears in the illustration simply to show cannula in operation, and of course is not made in the fowl.)

After removing the testicle, if the bleeding is at all profuse it is well to remove a portion of the blood by introducing small pieces of absorbent cotton into the body by means of the hook or nippers, allowing them to become saturated and then removing them. Be sure to remove all blood clots, feathers, or other foreign matter. After the testicles and all foreign matter are removed, take out the spreaders, thus allowing the skin to slip back over the incision. The method of using the twisting scoop is shown in figure 6.

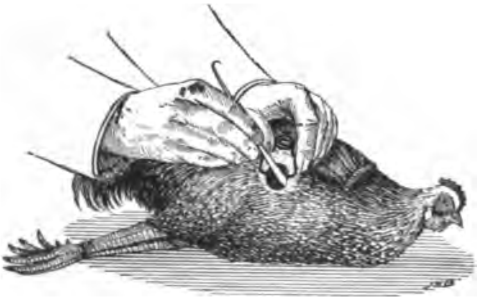
FIG. 6.—Twisting scoop in use.

LOSSES DUE TO CAPONIZING.

Some birds are sure to be killed even by experts, but the loss is small, seldom exceeding 5 per cent where any considerable number are caponized, and usually not more than 2 or 3 per cent. With beginners, of course, the percentage is much larger, but with a little practice and care this is soon overcome. Any fowls which may be killed in this way are perfectly good to eat and are therefore not wasted.

A great deal of practice is required to become expert enough to operate rapidly. Consequently it is quite common in localities where many capons are grown to hire experts to do the work. These men are able to caponize a fowl every two to five minutes, and charge from 3 to 6 cents a fowl for the service. It is most humane for the beginner to make his first trials upon dead fowls.

SLIPS.

Many times, particularly with beginners, while the operation seems to be entirely satisfactory, the bird will turn out to be what is known as a "slip." A "slip" is neither cockerel nor capon, but is between the two, possessing the mischievous disposition and the appearance of an ordinary cockerel, but, as a rule, being unable to reproduce. This condition is due to the fact that a small piece of the testicle is left in the body. This piece often grows to a considerable size. As the "slips" possess the same restless disposition as the cockerels, they grow and fatten little if any better, while they do not bring as good a price in the market as the capons. Consequently it is well to use every precaution in order to avoid "slips," as they are unprofitable as compared with capons. With the greatest care, however, "slips" are more common than are deaths due to the operation. The percentage varies all the way from 50 per cent with beginners down to 2 or 3 per cent with experts.

CARE OF FOWLS AFTER THE OPERATION.

Upon being released from the operating table the capons are usually put in a closed yard where they can find shelter, food, and water and can be kept quiet. No roosts are provided, as the less flying and jumping they do the sooner will the wound heal. The capons seem to be very little inconvenienced by the operation, and water and soft feed mixed with sweet skim milk can be given immediately. Some feeders give this in unlimited quantity, while others feed more sparingly for a time. Some growers observe no precautions whatever, giving the birds their full liberty immediately after the operation and allowing them to have any sort of feed.

For a week or 10 days the newly made capons should be carefully observed to see whether they become "wind puffed." This is a condition caused by air gathering under and puffing out the skin near the wound. When observed it can be readily relieved by pricking the skin with a needle or knife and pressing out the air. In about 10 days or 2 weeks the incision into the body should be entirely healed, and, although no special antiseptic methods are employed in the operation, blood poisoning or any other trouble seldom results.

FEEDING CAPONS.

Capons are usually kept till they are about 10 months old. At this time the market is at its best and the birds have made their most profitable gains. The feeds used and the methods of feeding vary greatly, so much so, indeed, that it is futile to try to give specific directions. For several months after the operation a good growing ration and not a fattening ration is required. It may consist of whole grains, ground grains, or a combination of the two, as each feeder finds most profitable and best suited to his locality. As with other poultry, variety must be given for best results. Late in the fall, when the capons have no pasture, green feed, such as cut clover or vegetables, should be provided. A somewhat more fattening ration than that required for laying hens seems to give good results.

As capons are not usually marketed before Christmas or the first of January they have to be housed during the late fall and early winter. Because of their quiet disposition they stand crowding quite well and have been successfully housed with only 2 or 3 square feet of floor space to a fowl. It is better, however, to allow 4 to 5 feet if possible.

During the last month or month and a half before marketing the corn in the ration should be gradually increased until the fowls are on a full fattening ration. For the last two or three weeks it is desirable to shut them up and feed them in crates, for every possible ounce at this stage adds to the appearance and profit. Machine cramming is sometimes practiced the last week with excellent results.

KILLING AND DRESSING CAPONS FOR MARKET.

KILLING.

The capons selected for killing should be confined for 24 hours without feed or water to completely empty their crops. The usual method of killing is known as the sticking method. The fowl is hung up by the feet, the head held in the left hand, and the whole body stretched to full length. The mouth is forced open, and by means of a sharp, narrow-bladed knife held in the right hand the blood vessels at the back of the throat are severed with a single sweep. The knife is then turned and the point plunged through the roof of the mouth to a point just behind and between the eyes. The brain is here reached, and if properly stuck all feeling is then lost. Convulsions ensue, the muscles are relaxed, and the feathers come out easily.

PICKING.

Capons should always be dry picked, as they look much better and as some of the feathers should be left on. The feathers of the neck and head, the tail feathers, those a short way up the back, the feathers of the last two joints of the wing, and those of the leg, about one-third of the way from knee to hip joint, should be left on. These feathers, together with the head of the capon, serve to distinguish it from other classes of poultry on the market, and consequently should never be removed. Figure 7 shows several capons dressed for market. Their condition, however, is rather poor and is capable of improvement. In picking be careful not to tear the skin. If bad tears are made sew them up. Capons scalded and picked bare bring very little, if any, better prices than other poultry in the same condition.

DRAWING.

Most markets require capons to be undrawn and the head and feet left on. If drawing is required the vent should be cut around and the intestine pulled out until the gizzard is reached, where it is broken off. Nothing else is removed. Care should be used to cleanse the head and feet of all signs of blood or filth.

COOLING AND PACKING.

After picking, the carcasses are hung in a cool place until the animal heat has entirely left the body, when they are ready to be packed. Like other poultry they should be packed in boxes of convenient size, holding about a dozen carcasses. Every attention should be given to neatness and attractiveness, as this helps the sale and the price. During the time of year when most capons are marketed—January, February, and March—no ice is necessary, but if for any reason they are shipped in warm weather they should be packed in ice.

PROFITS.

It is extremely difficult to make any general statement concerning the profits yielded by capons. That they do yield a profit in practically all cases is undoubtedly true, but whether the profit is sufficient to give up to them the time and room they require is a question which must be settled by each man's experience and by local conditions. Many poultrymen think that they can do better to turn off their surplus cockerels as broilers as long as the market holds up and rely upon caponizing only for later-hatched chicks. The house room thus saved they use for pullets or other laying stock, feeling that they make more money in this way. It is certain, however, that many poultrymen find capon raising profitable enough to induce them to continue

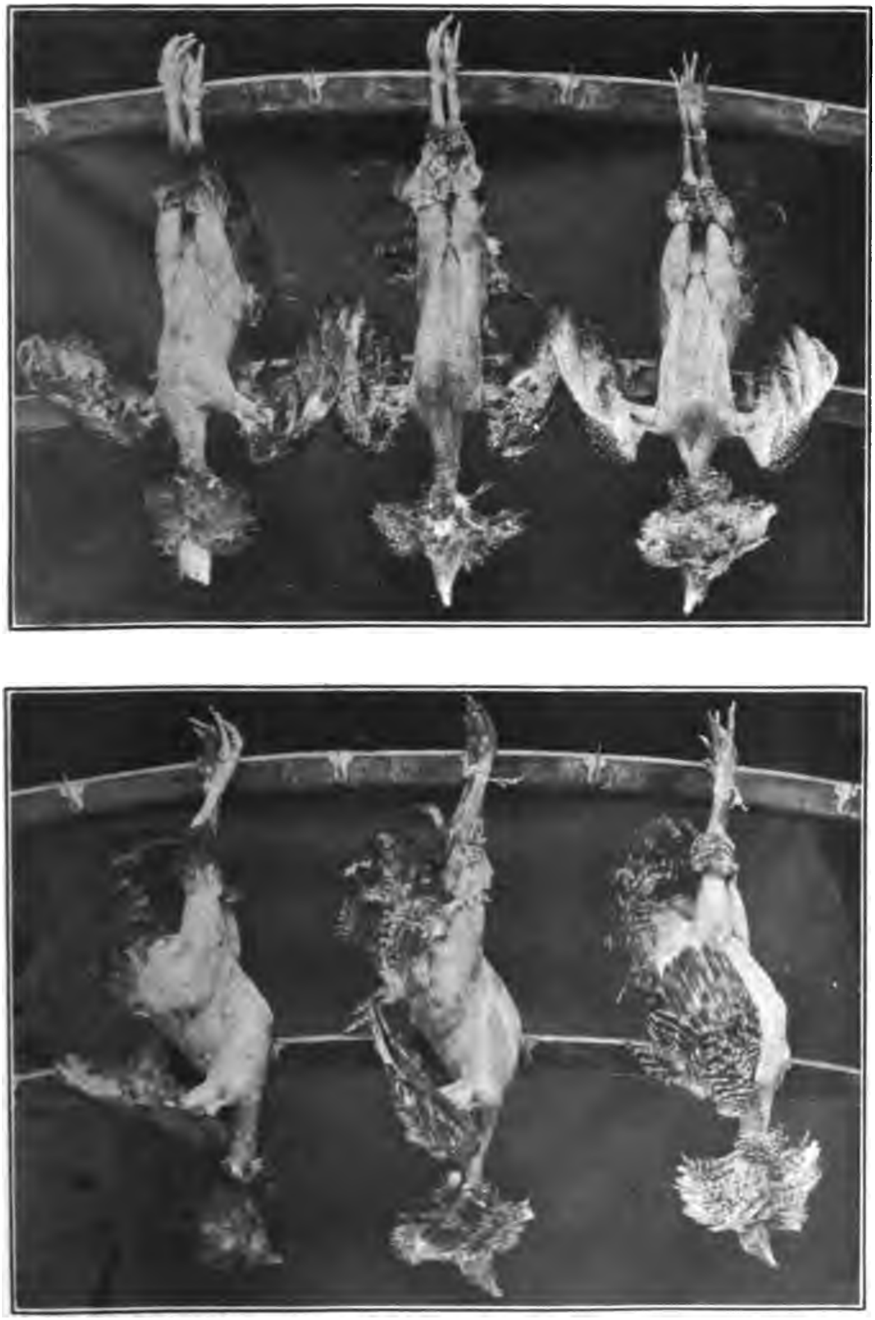

Fig. 7.—Capons dressed for market. These illustrations show appearance after picking, but do not show fowls in perfect condition of flesh.

in the business. On several farms in Massachusetts 500 to 1,000 capons are raised annually, and the writer knows of one farm on which in one season 5,000 cockerels were held for caponizing. Although the industry is growing rapidly year by year, the supply does not yet equal the demand. The best prices are commanded by capons produced near to the market, and consequently perfectly fresh. The markets of the West do not quote as good prices as the eastern ones, 13 and 14 cents being about the highest; hence most of the western-grown capons are shipped East, in which case the express rates cut down the profit materially. On the whole, the profit is probably rather greater for eastern producers than for those of the North Central States.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 453.

DANGER OF GENERAL SPREAD OF THE GIPSY AND BROWN-TAIL MOTHS THROUGH IMPORTED NURSERY STOCK.

BY

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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., March 27, 1911.

Sir: I have the honor to transmit, for publication, a paper dealing with the danger of the general establishment throughout the United States of the gipsy moth and the brown-tail moth, which have been during the preceding two years, and are again the present year, imported from European countries on nursery stock and widely distributed in the United States. While every effort has been made to examine and disinfect such imported stock, it is by no means certain that all of the infested shipments have been reported and examined by inspectors, especially as, in the absence of any law, all reports and work of this kind are more or less voluntary. There is, therefore, considerable danger that the brown-tail moth, or perhaps the gipsy moth, has already become established in one or more interior points.

This paper gives a record of the infested importations during the last two years and descriptions of nursery conditions in Europe, showing the nature of the infestation there, and concludes with a brief description, with illustrations, of the two moth pests which are now being thus imported. The publication is, therefore, a warning to users of such imported stock and gives descriptions and figures enabling the prompt recognition of either of these pests wherever they may become established.

The nonexistence of a general law providing for the reporting of all imported stock and for uniform and thorough inspection and disinfection of such stock makes it highly desirable that the information here given should be made promptly available and widely distributed.

I recommend its publication as a Farmer's Bulletin.

Respectfully,

L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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DANGER OF GENERAL SPREAD OF THE GIPSY AND BROWN-TAIL MOTHS THROUGH IMPORTED NURSERY STOCK.

INTRODUCTION.

Winter nests of the brown-tail moth, each filled with hundreds of young larvæ, and occasional egg masses of the gipsy moth have been brought into the United States, the former in enormous numbers, during 1909–10 on imported nursery stock, and the importations for the season of 1911 are again bringing in these brown-tail moth nests. This infested stock, coming largely from nurseries in northern France, has been scattered widely over the United States east of the Rocky Mountains, and while every effort has been made to trace these importations and inspect and disinfect them the probability of many unreported shipments or inefficient inspection is very great.

A general warning is therefore given to all users of such imported plant stock, namely, to nurserymen, fruit raisers, and purchasers of ornamentals for city or park planting, to keep all such imported stock under strict watch to see that these pests do not develop.

As an aid in this direction this bulletin has been prepared. It gives a record of the infested importations of the past two years, a review of the nursery conditions in Europe showing the nature of contamination there, and a brief description, with illustrations, of the two moth pests which are now being imported and widely distributed.

IMPORTATIONS OF INFESTED NURSERY STOCK OF 1909–1911.

Space will not be taken to give the details of the shipment and distribution of infested nursery stock during these years. Some idea of the situation can be gained, however, from the following brief summary of importations, drawn largely from the annual reports of the Bureau of Entomology by Dr. Howard for the two years in question.

BROWN-TAIL MOTH NESTS IMPORTED IN 1909.

Early in 1909 it was discovered that nests of the brown-tail moth, filled with hundreds of small hibernating larvæ, were being introduced into this country on imported European nursery stock—chiefly from northern France—and distributed into many States. These brown-tail moth nests were first reported in connection with a consignment of seedlings shipped from Angers, France, to New York. The nests were discovered by the New York State inspector, and the information was communicated to the Bureau of Entomology by the commissioner of agriculture of that State.

A little later information came from Ohio that the winter nests of the brown-tail moth had been found on seedlings imported into that State from the same locality in France.

Warning letters were promptly sent out by Dr. L. O. Howard, chief of the Bureau of Entomology, to the different entomologists, and special arrangements were made with the customs office, through the kindness of the Secretary of the Treasury, and by agreement with the railroads, so that this bureau was to be informed of all cases of plants received at customs or subsequently handled by the principal railroad companies. By this means the receipt and ultimate destination was ascertained of much of the imported stock of that year. This information was transmitted to the State inspectors and other competent persons near the points of ultimate destination of such packages and an effort was made to have all such imported material inspected.

Information was secured concerning nearly 800 shipments, divided among 35 different States. In shipments to 15 of these States, namely, Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, and Pennsylvania, nests of the brown-tail moth were found, ranging in number from one nest to many nests in each shipment. These brown-tail nests—little webbed packets of leaves containing the very small hibernating larvæ to the number of 300 or 400 in each nest—were found on the seedling and other nursery stock in enormous numbers, some 7,000 nests (approximately 2,800,000 larvæ) being found in shipments to New York State alone.

In one locality in Ohio an egg mass of the gipsy moth was found and Prof. P. J. Parrott, of the New York Experiment Station, at Geneva, N. Y., found another important European fruit pest (*Hyponomeuta padella*), which had probably been introduced on these same French seedlings.

BROWN-TAIL MOTH NESTS IMPORTED IN 1910.

In view of the dangerous conditions of the shipments of 1909, a strong effort was made on the part of Dr. Howard to have the French authorities provide for the competent inspection and disinfection of material preliminary to the shipping season of 1910. In spite of promises of the authorities that such inspection would be made, the shipments of nursery stock from France in 1910 again brought to this country enormous quantities of nests of the brown-tail moth, filled with the one-fourth grown larvæ. Moreover, one shipment of nursery stock from Belgium to Louisiana contained an egg mass of the gipsy moth.

All of this imported European stock was again followed up as far as possible in accordance with the arrangement of the previous year with the customs officers and by agreement with the railroads, and all reported shipments were inspected at their destination.

Of the shipments of 1910 not less than 291 different lots were found to be infested with nests of the brown-tail moth. These went to the following States: Colorado, Connecticut, Georgia, Illinois, Indiana, Kansas, Louisiana, Michigan, Montana, New Jersey, New York, Ohio, and Virginia.

BROWN-TAIL MOTH NESTS IMPORTED IN 1911.

As a result of a thorough investigation of European conditions, which will be described later, a much better effort during the last year has been made, notably in France and Belgium, to improve the conditions of export stock, and as a result the importations of the present season of 1911 so far have shown a very notable improvement in amount of infestation. Nevertheless, the imported stock still shows occasional infestation, and such infested stock is being widely distributed. The danger as the infestation becomes less general is perhaps just as great or even greater from the very natural lessening of care or greater haste which will be given to examinations, and one overlooked nest or egg mass is quite sufficient to establish these pests.

RECORDS OF DISTRIBUTION OF THE IMPORTED NURSERY STOCK INCOMPLETE.

Nursery stock imported by dealers and sent direct in bond to destination is probably all reported and subsequently examined. Much of the imported nursery stock is, however, handled by customs brokers or receiving agents in New York, and the different packing cases are so marked that these distributing agents know where to send them, and they are distributed widely over the country, often in bond, without being examined in New York, and often without any record being made of such shipment or final destination. As pointed out by Dr. Howard in his testimony before the House Committee on Agriculture, much of such nursery stock which enters at the port of New York and is thence distributed in original packages the Government has been able to trace through the courtesy of the railroads, in addition to the regular arrangement with the customs office to advise the Department of Agriculture on the receipt of such stock. Nevertheless, the information gained from the customs office is evidently incomplete, as very often the railroad companies report the handling of stock of which no advice has been gained by the customs office, and, on the other hand, material is reported by the customs office which is not reported by the railroad companies. For this reason there is no certainty that all of the imported stock is reported, and undoubtedly some of it is miscellaneously distributed and never is examined at all. This condition of affairs, from local experience in his State, was strongly brought out by Dr. J. B. Smith, entomologist of New Jersey, in his testimony before the House Committee on Agriculture.

Dr. Smith also called attention to two other features of the importation of nursery stock which have an important bearing on the entrance of such pests as the gipsy moth and the brown-tail moth. The first of these relates to the importation by large department stores of New York, Philadelphia, and Washington, and in large interior towns, of inferior stock of ornamental plants, roses, and even fruit trees, massed down under enormous pressure in large boxes, thousands of plants in a single case. This largely worthless and often infested stock is distributed by these agencies at a very low price, or is given to the customers, and goes in small parcels here and there where it can not be followed, and necessarily entails the greatest risk of the introduction of dangerous pests and plant diseases. It is almost impossible to make any proper examination of such material even when its importation and destination are reported. Some of these shipments contain hundreds of thousands of plants, so that the chances of overlooking infestation are exceedingly great.

The other condition referred to by Dr. Smith is the importation by private persons, owners of large estates, or head gardeners, of greater or less quantities of ornamental and floral stock, such miscellaneous importations being very difficult to get advice of, and undoubtedly many of them are never reported or inspected.

CONDITIONS IN THE DISTRICT OF COLUMBIA.

A recent and very undesirable development in the introduction of foreign nursery stock has come to light in Washington, D. C., and probably is occurring in other large cities. In the latter part of March it was learned that a large shipment of miscellaneous ornamental stock had been made by a Dutch nursery firm to a local auctioneer, to be sold under the hammer, and, on the authority of the auctioneer in question, without previous arrangement. This new development seems to have arisen from an experience of the previous year (1910), where a shipment of stock was refused by the consignee and was turned over to this same auctioneer for sale. The results were evidently sufficiently satisfactory to lead the Holland firm to make the shipment of stock this year direct to the auctioneer, on the chance of a profitable sale.

The situation in the District of Columbia is probably the worst in the United States, inasmuch as there is no law whatever which authorizes the examination or inspection of nursery stock imported into the District. Examination of stock imported by local department stores, by nurserymen, and that sent for auction, as noted above, can be made only by officials of the Department of Agriculture through the courtesy of these different receivers of such stock. Very often such courtesy is scant, or refusal is made to open up the stock or separate it so that it can be properly examined. Such stock, when reported, has, however, been as thoroughly inspected as conditions permitted. It is sold to a multitude of purchasers, many of whom reside in near-by points in Virginia and Maryland, and thus finds entry into these States without the knowledge of the State officials.

NATURE OF INSPECTION AND LIKELIHOOD OF LOCAL INFESTATION.

As already indicated, the principal function of the Bureau of Entomology has been to get as complete information of importations as possible and transmit this information to the State inspectors, where such existed, of the several States. In some instances, where no local means of inspection was available, the imported material was inspected directly by agents of this bureau. In most of the States receiving infested goods the inspection made was conscientious and thorough. In some instances, however, the inspection was undoubtedly indifferent or worthless. This is illustrated by the fact that material received by a large Missouri nurseryman, and on his own statement "carefully inspected," was reshipped by him to Maryland, still infested with the brown-tail moth.

The condition of the imported nursery stock is such as to make inspection difficult and also to render it practically impossible to be absolutely sure that the inspection has resulted in the detection and destruction of all larvæ. The nests themselves are sufficiently prominent to be easily seen if the masses of thousands of plants in a case are properly separated so that each can be given individual examination. This means, however, a lot of time and absolute conscientiousness on the part of the inspector.

Many of the nests, however, in the process of packing and unpacking become broken and the minute larvæ are scattered more or less through the seedling stock and also in the packing material. Under these conditions, the chance of larvæ being overlooked by the inspector is very great. It by no means follows, therefore, that even where material is located and inspected the brown-tail moth and perhaps other pests have not been introduced. Furthermore, the unpacking is done, in many nurseries, in the open, in close proximity to growing nursery or ornamental stock, and the packing straw and wrappings are piled about and touching growing or heeled-in trees, so that plenty of opportunity may exist for the moth larvæ, in such packing material or otherwise scattered, to find lodgment and opportunity for development.

There is also, in addition to the difficulties experienced in actual inspection, the very large risk, already indicated, that many shipments are not inspected at all.

The fact that the brown-tail moth or any other pest does not develop immediately in the regions where these infested shipments are opened is no indication that such pests have not been introduced and that they will not eventually become established. When in very scanty numbers, they are inconspicuous enough to be easily overlooked for a number of years, as was illustrated in the case of the gipsy moth near Boston, which remained slowly increasing for over 20 years before it came to public notice. The brown-tail moth, brought in on roses, probably from Holland, about 1890, also had become thoroughly established over quite a large area before it was recognized, in 1897, as a new pest. The latter case is all the more instructive because the brown-tail moth was developing in the very region which was then being thoroughly examined every year for the gipsy moth. It may well be possible, therefore, that either the brown-tail moth or the gipsy moth is now slowly gaining headway at different points in one or more States as a result of the shipments of infested material of 1909 and 1910.

SIGNIFICANCE OF IMPORTATIONS OF 1909–1911.

It is scarcely necessary to comment on the tremendous danger which the importations of nursery stock of the last three seasons have brought to this country. The enormous cost of the gipsy moth and the brown-tail moth in New England is now well known. Throughout the infested districts of New England orchards have been completely destroyed and forests largely obliterated, and even where woodlands and parks have been protected at an enormous expense their beauty and value have been vastly lessened.

Massachusetts has spent millions of dollars in an effort to control these pests, and with their spread to other States the work of control has been taken up in these also. The National Government has been asked to come to the rescue, and is now appropriating $300,000 a year in the mere attempt to check the distribution of these pests along the principal highways. Massachusetts and the other infested New England States are now spending more than a million dollars a year in control work. In spite of these efforts and this enormous expenditure the gipsy moth and the brown-tail moth are steadily spreading in New England and great damage is experienced from them yearly. Extermination is entirely out of the question, and all these expenditures must go on indefinitely at a probably increasing rate, unless some natural check by means of parasites can be brought about.

In addition to the great destructiveness of these pests to orchards and forests, their establishment in any suburban residential district means an enormous depreciation in property values, as is now illustrated about the city of Boston, and very notably lessens the attractiveness of coast or mountain summer resorts. The north shore towns of Massachusetts and lower Maine resorts have already felt this influence, and for such regions as the Catskills or Adirondacks the establishment of these pests would be most disastrous, inasmuch as control over such extended forested mountains is practically impossible.

When it is realized that these two pests have been widely distributed, on imported nursery stock, in 22 States during the years of 1909 and 1910, and are now coming in on imported stock from France and Belgium, the danger to the whole country is fully apparent, and this danger applies to every orchard and to every owner of private grounds and also to our entire forest domain. The tax from these pests, should they gain foothold throughout the country, as measured by the existing cost in New England, is almost beyond estimate.

EFFECT OF THE BROWN-TAIL MOTH ON HEALTH.

In addition to the great monetary loss, the brown-tail moth exercises a very deleterious effect on health. The hairs which cover the caterpillars of this moth are strongly nettling, and not only are they so from accidental contact with a caterpillar which may fall on clothes, face, neck, or hands from an infested tree, but also from the myriads of hairs which are shed by these caterpillars when they transform to the chrysalis state. The latter fall and find lodgment on clothing, or collect on the face, neck, or hands, and frequently cause very disagreeable and extensive nettling, the effects of which may last for months. Breathed into the lungs they may cause inflammation and become productive of tuberculosis. The brown-tail rash is well known throughout the regions infested in New England and thousands have suffered from it. All of the assistants who have been connected with the Government work with these pests in the New England States have been seriously poisoned. Two of them have had to give up their work and go to the Southwest to attempt to recover from pulmonary troubles superinduced by the irritating hairs of the brown-tail moth, and the death of one man employed on the work was due to severe internal poisoning contracted in field work against larvæ.

This insect is, therefore, a most undesirable neighbor, even if it were not responsible for great injury to orchards and ornamental trees.

CHARACTER AND VALUE OF IMPORTED NURSERY STOCK.

The actual value of the importations of nursery stock which is thus jeopardizing the entire fruit and forest interests of this country, as declared at customs during the years 1907 and 1908, of which we have tabulated records, is about $350,000 annually, but little more than the sum which the United States Government is spending every year in an endeavor to eliminate the spread of the gipsy moth and the brown-tail moth, and one-third the sum which the New England States are spending annually in an attempt to control these pests.

The major part of the imported stock consists of seedling apple, pear, plum, and cherry from north France. There is also considerable importation of ornamental and flowering plants, shrubs, and trees. The latter is purely commercial, and comes in very largely for the reason that it can be produced more cheaply abroad than in this country. Of the seedling stock, it is claimed by nurserymen that the imported plum, cherry, and quince stock particularly is much better material for grafting purposes than home-grown seedlings. In the case of the apple seedlings, however, the great mass of such stock is still produced in this country and can undoubtedly be just as well produced here, if not better, than in France or elsewhere in Europe.

The stock of the last two years which has been most infested has come from northern France, accumulated from various smaller or larger nurseries, including a French seedling agency, managed by an American corporation composed largely of New York nurserymen.

If, as is claimed, some of this seedling stock is better than any that can be produced in this country, it becomes all the more imperative that such stock, or all imported stock, should be subject to rigid inspection, and that every possible means should be taken to safeguard this country from the further establishment of these two very dangerous insect pests.

EUROPEAN NURSERY CONDITIONS.

During the summer of 1909, and also again in 1910, Dr. Howard, who was in Europe principally to supervise the introduction of parasites for the gipsy and brown-tail moths into Massachusetts, made a careful inspection of the nursery regions of Holland, Belgium, and northern France, and also England.

The writer was in Europe, on a personal trip, in the summer of 1909, and made an examination of similar conditions in Holland, Belgium, and parts of Germany.

Holland probably presents the cleanest bill of health in the matter of insect pests, and particularly of the gipsy moth and brown-tail moth. This country enjoys a good inspection service, and all Dutch nurseries are carefully inspected twice each year, so there is probably less danger now from shipments from Holland than from any other country.

Belgium, in 1909, was in very bad condition, and the writer found the brown-tail moth more abundant there than he had ever seen it, hedge rows often being plastered with the winter nests. One such row the writer noted was only a few miles from the border of Holland and within easy flight of the moths to large Dutch nurseries. Belgium has, however, since September, 1909, established an inspection service, applying only to nurseries exporting to America and limited to field examination, twice yearly, of growing stock. While a distinct improvement, the inspection as indicated is still inadequate, as shown by much infested stock still coming to this country under official certificate.

In France, in 1909, Dr. Howard found no governmental inspection system of nurseries. The certificates attached to shipments of nursery stock received in this country from France were signed, as a rule, by men connected with agricultural schools, and probably in the case of most of the certificates the stock had never been seen by the expert. The general infestation of the stock coming from France to this country during the last two years made it abundantly plain that these certificates were absolutely valueless.

Dr. Howard found that nursery stock for export was in many cases grown in the vicinity of hedges and trees infested with the brown-tail moth and gipsy moth and other injurious insects not yet introduced into the United States, and no special precautions were being taken by the nurserymen to prevent the infestation of export stock by injurious insects. The brown-tail moth nests are so characteristic and noticeable that it is only by absolute indifference on the part of French exporters that they are packed for shipment without removal.

As a result of the agitation of 1909, the French exporters promised to take all possible precautions, and the French ministry of agriculture promised to found a governmental inspection service. The Chamber of Deputies, however, failed to pass the inspection law proposed by the ministry of agriculture, and, as already noted, the condition of the "inspected material" of 1910 was no better than in the previous year.

The director of agriculture of France, however, continued to urge the need of a plant-inspection service for export nursery stock, and early in November of 1910 this department was advised, through the Department of State and the ambassador of France to the United

States, of the final establishment of such service. Later the details of the law were communicated to Dr. Howard by Dr. Paul Marchal, who is charged with its execution.

Dr. Marchal's high reputation gives a guarantee of thoroughness, and a great improvement has actually taken place in the condition of the nursery stock coming from France. The rank infestation of 1909–10 has given place to moderate infestation of 1911, but there is still decided room for betterment.

In England Dr. Howard found that, as in France, there was no governmental nursery inspection. The nursery conditions there are somewhat better than in France, but the brown-tail moth and other injurious insects which might easily be imported on nursery stock occur in England. The officials of the Government had the establishment of a governmental inspection service under consideration, and were willing to establish such a service, but stated that the demand for it must come from British nurserymen. An attempt was therefore made by Dr. Howard to get these interests to ask for such service, and, while no action has yet been taken, it seems probable that the English Government will move in this direction.

IMPORTATION OF REFUSE STOCK.

The fact that all the continental countries of Europe have enacted very strict inspection and quarantine laws relating to the entrance into their territories of nursery stock, or other living plant materials, operates very unfavorably for this country, where there is no bar to the entrance of any stock, however worthless, or insect-infested, or diseased. As a result, the United States receives, in addition to fairly good nursery stock brought in by reliable importers, a great mass of refuse stock, imported under the worst conditions, massed in vast quantities in large packing cases, at best in poor condition and often diseased or insect-infested. The United States thus becomes a sort of dumping ground for material which could not find sale in Europe. Much of this worst-quality stock is that referred to elsewhere as being imported by department stores of our larger cities, and also by unscrupulous nurserymen who are careless of their own reputations and the interests of their customers.

NECESSITY OF QUARANTINE LEGISLATION.

The necessity of National quarantine to prevent the general introduction of such dangerous insect pests as those discussed in this bulletin, and also of equally dangerous plant diseases, has long been recognized.

The need of legislation is much increased by the fact that the United States is the only great power without protection from the importation of insect-infested or diseased plant stock. Referring to European powers only, Austria-Hungary, France, Germany, Holland, Switzerland, and Turkey prohibit absolutely the entry from the United States of all nursery stock whatever. Furthermore, our fruits are admitted to these countries only when a most rigid examination shows freedom from insect infestation. Most of the other European countries have strict quarantine and inspection laws, and the same is true of important English and other colonial possessions.

A properly enforced quarantine inspection law in the past would have excluded many, if not most, of the foreign insect enemies which are now levying an enormous tax upon the products of the farms, orchards, and forests of this country. Fully 50 per cent of the insect pests in this country are of foreign origin, and new important foreign pests are becoming established practically every year.

It is of the greatest importance, therefore, that an adequate inspection and quarantine law be passed at the earliest moment.

BRIEF DESCRIPTION OF THE DIFFERENT STAGES OF THE GIPSY AND BROWN-TAIL MOTHS.

THE GIPSY MOTH.

The gipsy moth (*Porthetria dispar* L.) is an European pest which was accidentally introduced into Massachusetts nearly 40 years ago, and has since spread rather slowly, being still confined to the eastern part of Massachusetts and Rhode Island, the southern part of New Hampshire, and to more or less isolated localities in eastern Connecticut and southwestern Maine.

The presence of this insect was first discovered in Boston in 1889, and the State of Massachusetts for a number of years kept up a vigorous effort to exterminate the insect, making large appropriations therefor. This work was abandoned, however, in 1900, but the conditions soon became so bad that appropriations were again made in 1905, and have since been continued annually., In spite of the work of that State, the situation became so serious that the National Government, particularly on the ground of the great danger that these pests would soon spread to other States, was called upon to assist, and since 1907 Congress has been making annual appropriations to aid in the work of control. The amount of this appropriation is now $300,000 annually.

The destructive work of the gipsy moth has been referred to in the foregoing portions of this bulletin. A brief sketch is here given of the life history and habits of the insect with photographs to aid anyone in promptly recognizing it should it appear in new localities.

The gipsy moth has a wide distribution throughout middle and southern Europe, northern Africa, and Asia, including Japan. In a large portion of the Old World range of the gipsy moth it is occasionally abundant and injurious, but as a rule it is held in check by parasites and natural enemies, and in no instance have there been such continuous and disastrous depredations as those exhibited in Massachusetts and more recently in the adjacent New England States.[1]

European outbreaks usually terminate in two or three years. Nevertheless in recent years in Europe and Asia exceptional outbreaks have occurred in which thousands of acres of forests have been completely denuded, and where such denudation has been repeated for two or three years in succession enormous areas have been found covered with dead and dying trees.

The following description of the different stages and habits of the insect is reproduced from Farmers' Bulletin 275 (pp. 12 to 15):

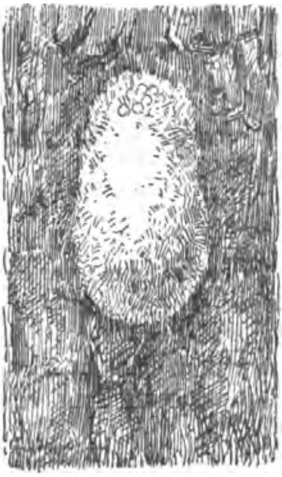

FIG. 1.—Egg mass of the gipsy moth (*Porthetria dispar*). (From Kirkland.)

Description of the different stages of the insect.

The eggs.—The eggs of the gipsy moth are laid in masses (fig. 1) of about 500. The individual egg is minute, about the size of a pinhead, and is salmon-colored when first laid, but turns dark in the course of a few weeks. Each egg mass is yellowish in appearance and seems covered with hair. It is somewhat oval, being one-half of an inch long and about three-fourths of an inch wide. During winter, from exposure to moisture in the atmosphere, it becomes dingy white in color. Egg masses have been found on bark of imported stock during the last two years, and inspectors should be on the lookout for them.

The larva, or caterpillar.—The young larvæ or young caterpillars are dark in color and well furnished with dark hairs. The full-grown larva (fig. 2) is between 2 and 3 inches long, dark brown or sooty in color, with two rows of red spots and two rows of blue spots along the back, and with a yellowish but rather dim stripe between them. The body generally is clothed with long hairs, and sometimes reaches the length of 3 inches.

The pupa.—The pupa (fig. 3) is not inclosed within a perfect cocoon, but the full-grown larva spins a few threads of silk as a sort of support and changes to the pupa, which is dark reddish or chocolate in color and very thinly sprinkled with light reddish hairs.

The adult, or moth.—The male moth (fig. 4) is brownish yellow in color, sometimes having a greenish-brown tinge; it has a slender body, well-feathered antennæ, and a wing expanse of about an inch and a half. The forewings are marked with wavy zigzag darker lines. It flies actively all day as well as by night.

The female moth (fig. 5) is nearly white, with slender black antennæ, each of the forewings marked with three or four zigzag, transverse, dark lines, and the outer border of both pairs of wings with a series of black dots. The body of the female is so heavy as to prevent flight.

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[1] For a more detailed account of the gipsy moth, see Farmers' Bulletin No. 275 (1907) and Bulletin 87 (1910), Bureau of Entomology, U. S. Department of Agriculture.

Seasonal History.

The moths emerge from the pupæ from the middle of July to the middle of August, the date varying considerably according to the season. After mating they live but a short time, and the female dies after depositing her eggs.

The eggs are laid therefore in July and August. They are deposited by the moths on the trunks of the trees upon which the caterpillars have lived, and in fact usually in the vicinity of the place where the female has transformed. The caterpillars before transforming frequently crawl for some distance from the trees upon which they have been feeding, and it therefore happens that the egg masses will be found on fences and in all sorts of protected situations in which the caterpillars hide during the day. The crevices in stone fences often contain very many of these egg masses, and knot holes in old trees will also contain many which would not at first be discovered. The egg masses are found also in hollow trees, in crevices under rough bark, on shrubbery, on buildings, in woodpiles, in barrels; in boxes, and among rubbish in dooryards. The moths seem to choose the inner or lower surface of an object upon which to lay their eggs, and therefore egg masses are placed out of sight perhaps as often as in sight.

The eggs hatch about May 1, and the young caterpillars begin immediately to feed, usually upon the lower surfaces of the leaves. As they grow they cast their skins several times, and as they become larger they feed only at night, hiding during the daytime, usually in clusters on the shady side of tree trunks, beneath large limbs, in holes in trees, under loose bark, and in fact under any near-by shelter. It is the habit of most of them to descend before daybreak upon the trunks of the trees and to seek for such shelters as those just indicated, returning after nightfall to resume their nocturnal feeding.

The larvæ usually become full grown about the 1st of July, and then transform to pupæ. The pupæ are found in the same situations as those we described for the egg clusters, but are found also in the foliage of trees and shrubs.

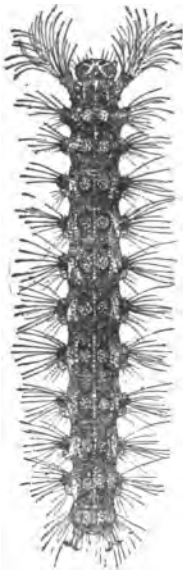

FIG. 2.—Full-grown caterpillar of the gipsy moth. Natural size. (From Insect Life.)

How the Insect Spreads.

As indicated above, the bodies of the females are so heavy as to prevent flight. Therefore the insect must be principally distributed while in the caterpillar or larval condition. The caterpillars are active crawlers, but as a rule do not migrate from the localities where they were born except when food is scarce. When young, and when there is hardly enough food, the larvæ spin down from trees by means of silken threads and often alight upon vehicles of one kind or another, and are thus carried often for great distances from the place of birth. Trolley cars, carriages, automobiles, and bicycles are thus means of transportation almost unlimited in their possibilities. The caterpillars often crawl upon vehicles which happen to stand for any length of time in an infested locality, and thus may be carried great distances. Sometimes even pedestrians aid unwittingly in this distribution, since the caterpillars may drop by their threads upon the garments of a person passing under an infested tree.

The species may be transported, too, in the egg stage on nursery or ornamental stock, as already noted, and it has been shown that the egg clusters are laid upon many different kinds of objects. Cord wood stacked and piled may be carried away in the autumn bearing many egg masses, and, if not burned before summer, larvæ may issue in a new locality. The same may be said for lumber piles near infested trees. Freight cars may have been sidetracked near an infested place long enough to permit laying of the eggs upon them.

It is by these methods that the comparatively rapid spread of the insect previously noticed, during the years 1900–1905, is to be explained.

Damage to Plants.

The larva of the gipsy moth feeds upon the foliage of practically all orchard trees, all shade and ornamental trees, all out-of-door shrubs, and all forest trees. Not only are the deciduous forest trees stripped, but the coniferous trees as well. In June and July patches of forests in the infested territory are stripped of every green leaf and the trees appear as bare as in winter. After several such consecutive strippings, deciduous forest and shade trees are killed, but with a coniferous tree, such as a pine, hemlock, or spruce, one complete stripping will cause death. It is this fact which makes the gipsy moth so much more serious a pest than the brown-tail moth, and the loss which will result from its spread into northern New England will be very great, owing to the enormous coniferous forest interests in that part of the country.

In cities and towns the insect does damage not only by destroying all vegetation, but by swarming in numbers upon and about houses, frequently entering them. It has been the experience in eastern Massachusetts that where a locality becomes thoroughly infested the value of real estate rapidly depreciates, and it becomes a matter of difficulty to rent or sell property.

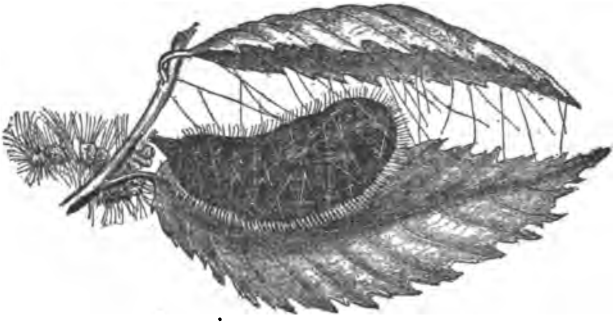

FIG. 3.—Pupa of the gipsy moth. Natural size. (From Insect Life.)

Among its food plants the gipsy moth caterpillar seems to prefer apple, white oak, red oak, willow, and elm, but those who have studied it most carefully in Massachusetts say that it will on occasion devour almost every useful grass, plant, flower, shrub, vine, bush, garden, or field crop that grows in the State.

THE BROWN-TAIL MOTH.

The brown-tail moth (*Euproctis chrysorrhœa* L.) was imported by a florist in Somerville, a suburb of Boston, about 20 years ago, probably on roses from Holland or France. Its presence was not discovered until 1897, when it had already gained such headway that extermination was out of the question. Since 1907 it has rapidly spread, and its range now includes much of the coastal area of New England, including eastern Rhode Island, the eastern half of Massachusetts, the eastern half of New Hampshire, and the southern half of Maine. Both sexes are strong fliers, and the prevailing winds during the flying season (July) have carried the insect northward and eastward, rather than southward and westward. Moths of this species have been taken as far away from Boston as St. Johns, New Brunswick.

This insect is a very serious enemy of orchard, forest, and shade trees and all ornamental shrubbery. In Europe it has a wide distribution, extending from England to the Himalayas, and as far north as Sweden and as far south as Algeria. It is a well-known orchard pest, and for many years laws have been operative in Europe requiring the property owners to clear their trees of the hibernating nests of this insect in winter.

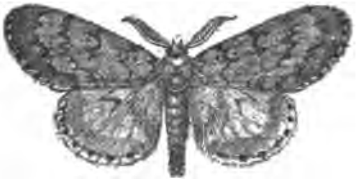

FIG. 4.—Male gipsy moth. Slightly enlarged. (From Insect Life).

The damage to trees and shrubs by this insect is often very severe. It has a special liking for pear and apple, but has a recorded list of over 80 different food plants. Thousands of fruit trees in the vicinity of Boston have been killed by this insect, and serious injury has been done to woodlands and forests, not, however, equaling the damage by the gipsy moth. It does not seem to attack coniferous trees.

One of the most serious results of the presence of the brown-tail is the poisoning of human beings by the hairs shed by the caterpillars, discussed in an earlier paragraph of this publication (p. 11).

The following description of the different stages of the insect and its seasonal history is taken from Farmers' Bulletin 264, which gives a general account of this pest, with general methods of controlling it.[1]

Description of the Different Stages of the Insect.

The eggs.—The eggs of the brown-tail moth are small and globular, and are laid in masses on the underside of leaves in the latter part of July. The egg masses are brown in color and are covered with hair, each mass containing about 300 eggs. They are much smaller than the egg masses of the gipsy moth, with which they are most likely to be confused, and average about two-thirds of an inch in length by about one-fourth of an inch in width. They are thus elongate in form, and are convex.

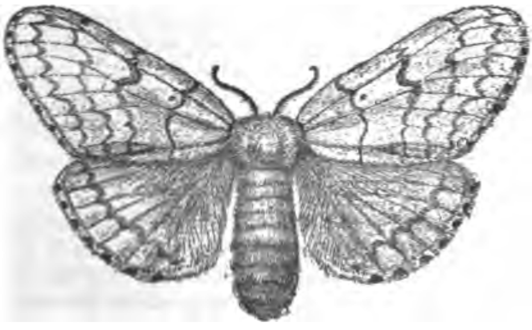

FIG. 5.—Female gipsy moth. Slightly enlarged. (From Insect Life.)

The larva, or caterpillar.—The full-grown larva (fig. 6 at right) is about 2 inches long, reddish brown in color, with a broken white stripe on each side and two red dots on the back near the hind end. It carries also patches of orange and is covered with tubercles bearing long barbed hairs. The tubercles along the back and sides are covered with short brown hairs in addition to the longer ones, which give the tubercles when magnified an appearance like velvet. The head of the larva is pale brown with darker mottlings.

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[1] For a full account of the brown-tail moth see Farmers' Bulletin 264 (1906) and Bulletin 87 (1910), Bureau of Entomology, U. S. Department of Agriculture.

The young larvæ are of a blackish color covered with reddish brown hairs. The head is jet black. Close examination will show projecting from the back of the fourth and fifth abdominal segments a large tuft of reddish brown hairs, and on the middle line of the ninth and tenth segments is an orange or reddish tubercle which may be withdrawn into the body. After the second spring molt the larva is about three-eighths of an inch long, the yellow markings on the body are more apparent, and the brown tufts on the back less prominent, while the band of white dashes along the sides, characteristic of the full-grown larva, is noticeable.

The pupa.—The full-grown larva spins a cocoon of grayish silk, which is very loose in its construction and is so far from being compact that the pupa may be readily seen through it. The pupa itself is about five-eighths of an inch long, dark brown in color, with a conical spine at the end of the abdomen bearing a cluster of minute hooks at the tip. Smooth, yellowish brown hairs are found scattered over the abdomen and the top of the thorax.

The cocoons are apparently spun by preference among the leaves at the tips of branches, and often a dozen or more larvæ will spin a common web within which each individual forms its own cocoon and transforms to pupa. The cocoons are also found under fences and beneath the edges of clapboards. Mr. Kirkland has seen a mass of cocoons nearly 2 feet across in the cornice of a house in Somerville.

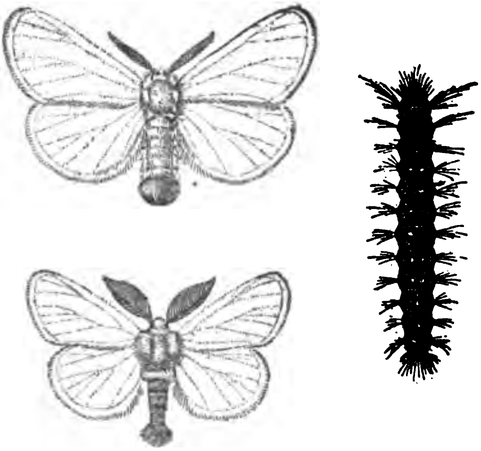

Fig. 6.—The brown-tail moth (*Euproctis chrysorrhœa*): Female moth above, male moth below, larva or caterpillar at right. Slightly enlarged. (From Howard.)

The adult, or moth.—The moths (fig. 6, at left) are pure white, the end of the abdomen being brownish, and both sexes bear at the tip of the abdomen, more conspicuously with the female, a tuft of brown hairs, almost globular in form, from which comes the name brown-tail moth. It is the only moth occurring in America to which this description applies, and is therefore unmistakable. The female expands about 1½ inches, and the male is smaller.

Seasonal History.

The moths fly in New England from the 1st to the 20th of July, the time varying with the condition of the season. In 1898 the height of the flying season is said by Fernald and Kirkland to have been July 16, in 1899 July 8, and in 1902 July 14. It is a night-flying insect, and only a few are ever seen on the wing in the daytime. Soon after sunset a few begin to fly, the number increasing as it grows dark, and from 10 o'clock to midnight they swarm to the greatest extent. They are strong flyers, and are attracted to light. So great have been their numbers in the infested region that the sides of red brick buildings near electric lights have appeared perfectly white. It is at this time that the great spread of the species occurs, and the reason that the direction of the spread has been greatest toward the northeast has been the fact that the prevalent night winds at that time of the year seem to have been from the southwest. Aside from actual flight, the species has spread by being carried in the moth condition on railway trains and on vessels. Captains of vessels have reported that the moths have alighted upon their ships in great numbers in the vicinity of Boston along toward midnight on several occasions, and the introduction of the species at more than one seaport in Maine has been by means of vessels coming from the infested district rather than by direct flight. Of course, the brown-tail moth is carried in the caterpillar stage, just as is the gipsy moth, upon vehicles of different kinds passing through the infested region and upon the persons of pedestrians as well. In late May, 1906, the writer, in company with three other persons, walked through the woods in a region not far from Boston, and although the most careful efforts were made by each of us to pick the caterpillars from the clothes of the others, an hour or two afterwards, and many miles away by automobile, still others were found under the upturned trousers and lapels of coats and in other hidden places about garments.

The eggs are laid by the moths soon after the flight begins, say in the latter part of July. They hatch during August and the young larvæ feed in clusters on the upper surface of leaves, skeletonizing them and causing the foliage to turn brown as if blighted. At first they feed upon the leaf which bears the egg mass, but soon wander to others, returning at night to the original leaf. When first hatched they are about one-twelfth of an inch long, and in five to six days shed their skin, increasing in length to one-fifth of an inch.

Later the second molt occurs, although this sometimes does not take place until autumn within the winter web. Along in September they begin to spin their winter webs by drawing together a number of leaves with silk, and in each of these nests a large number of caterpillars stow themselves away for the winter. These webs or nests, composed of leaves and silk, will average from 5 to 6 inches in length, and each will contain 200 or more caterpillars. The caterpillars feed until cold weather, and then all enter the web and close the exit holes. They are then about one-fourth grown.

These winter webs (fig. 7) of the brown-tail moth are very characteristic, and there are practically no other insect structures common upon trees which may be mistaken for them. There are certain old webs of native species which might possibly, by the untrained eye, be considered to be those of the brown-tail moth, but these are empty in the winter time. Any web of this character and general size found during the winter which contains young caterpillars in any number is the web of the brown-tail moth.

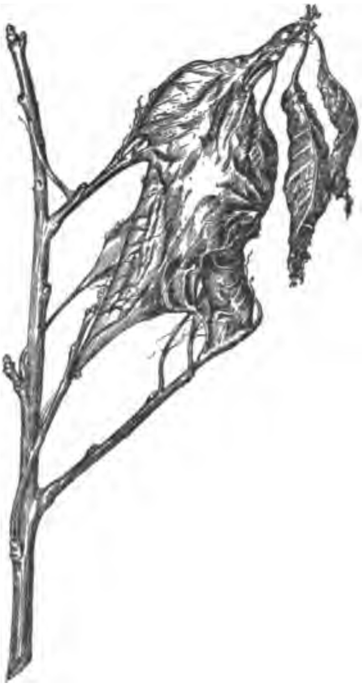

FIG. 7.—Winter nest of the brown-tail moth, containing 300 or 400 young caterpillars. (Original.)

The following spring, as soon as the buds begin to appear upon fruit trees, these young, one-fourth-grown caterpillars issue from the overwintering nests and attack first the buds and blossoms and later the foliage. Apparently half starved by their long hibernation, they come out with voracious appetites, and the amount of damage done by them at this time is extraordinary. Old trees may lose all their buds, or, if the leaf buds and blossom buds burst, the foliage itself may be entirely destroyed at a later date. The growth of the larva is rapid, and it reaches full size and begins to spin its cocoon during the last half of June, transforming to pupa and remaining in this condition for approximately 20 days.

Damage to Plants.

As just indicated, the damage to trees and shrubs may be very severe. The list of food plants is very extensive. While there seemed at first to be a preference for pear and apple, the larvæ were found to feed also upon the stone fruits, as well as upon the elm, maple, and several species of oak. Of late years there has been a very extensive infestation of scrub oak and of the larger trees of the genus Quercus. In fact, the caterpillars feed generally upon all deciduous trees, on many shrubs, and even upon herbage. A list of over 80 different food plants was published by Fernald and Kirkland in 1903. Thousands of fruit trees in the vicinity of Boston have been killed by this insect. Injury to woodlands and forests has not been as severe as that accomplished by the gipsy moth, and coniferous trees do not seem to be attacked, but the damage to oak, maple, and elm in the wooded region has been sufficient to cause the forests to appear brown in June in places, and complete defoliation for a series of three or four years has brought about the death of many trees. Even where the tree survives, its growth has been checked, and there is a timber loss.

FARMERS' BULLETINS.

Bulletins in this list will be sent free, so long as the supply lasts, to any resident of the United States, on application to his Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. *Because of the limited supply, applicants are urged to select only a few numbers, choosing those which are of special interest to them.* Residents of foreign countries should apply to the Superintendent of Documents, Government Printing Office, Washington, D. C., who has these bulletins for sale. Price 5 cents each to Canada, Cuba, and Mexico; 6 cents to other foreign countries. The bulletins entitled "Experiment Station Work" give briefly the results of experiments performed by the State experiment stations.

22. The Feeding of Farm Animals.
27. Flax for Seed and Fiber.
28. Weeds: And How to Kill Them.
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32. Silos and Silage.
34. Meats: Composition and Cooking.
35. Potato Culture.
36. Cotton Seed and Its Products.
44. Commercial Fertilizers.
48. The Manuring of Cotton.
49. Sheep Feeding.
51. Standard Varieties of Chickens.
52. The Sugar Beet.
54. Some Common Birds.
55. The Dairy Herd.
56. Experiment Station Work—I.
60. Methods of Curing Tobacco.
61. Asparagus Culture.
62. Marketing Farm Produce.
64. Ducks and Geese.
65. Experiment Station Work—II.
69. Experiment Station Work—III.
73. Experiment Station Work—IV.
77. The Liming of Soils.
78. Experiment Station Work—V.
79. Experiment Station Work—VI.
81. Corn Culture in the South.
82. The Culture of Tobacco.
83. Tobacco Soils.
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85. Fish as Food.
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91. Potato Diseases and Treatment.
92. Experiment Station Work—IX.
93. Sugar as Food.
96. Raising Sheep for Mutton.
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99. Insect Enemies of Shade Trees.
101. Millets.
103. Experiment Station Work—XI.
104. Notes on Frost.
105. Experiment Station Work—XII.
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127. Important Insecticides.
128. Eggs and Their Uses as Food.
131. Household Tests for Detection of Oleomargarine and Renovated Butter.
133. Experiment Station Work—XVIII.
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135. Sorghum Sirup Manufacture.
137. The Angora Goat.
138. Irrigation in Field and Garden.
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140. Pineapple Growing.
142. Nutrition and Nutritive Value of Food.
144. Experiment Station Work—XIX.
145. Carbon Bisulphid as an Insecticide.
149. Experiment Station Work—XX.
150. Clearing New Land.
152. Scabies of Cattle.
154. Home Fruit Garden: Preparation and Care.
155. How Insects Affect Health in Rural Districts.
156. The Home Vineyard.
157. The Propagation of Plants.
158. How to Build Small Irrigation Ditches.
162. Experiment Station Work—XXI.
164. Rape as a Forage Crop.
166. Cheese Making on the Farm.
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172. Scale Insects and Mites on Citrus Trees.
173. Primer of Forestry. Part I: The Forest.
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176. Cranberry Culture.
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264. The Brown-tail Moth and How to Control It.
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FARMERS' BULLETIN 454.

A SUCCESSFUL NEW YORK FARM.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 13, 1911.

Sir: I have the honor to transmit herewith a paper entitled "A Successful New York Farm," by Mr. M. C. Burritt, scientific assistant, prepared under the direction of the Agriculturist in Charge of the Office of Farm Management. I recommend that this be published as a Farmers' Bulletin.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—663.

A SUCCESSFUL NEW YORK FARM.

INTRODUCTION.

Twenty years ago farming in New York State did not offer the inducements which it now holds out. The prices of farm crops were low and land values were on the decline. The temptation for a young man who had the opportunity to go to the city and seek employment there was very great. The following is the story of a plain New York farmer who did not take this opportunity, but who remained on the farm to work out its problems, even in the face of unfavorable conditions. The farm in question was a very ordinary one located in Monroe County, in western New York, and the circumstances under which the farmer began business were those so common in the East at the time. The farm mortgage, notes to dealers for machinery and to neighbors and others for stock, the general disorganization of the farm, with its poor fences, poor drainage, more or less run-out land, and many other similar accompanying circumstances, were all present.

Mr. T. E. Martin, though born and reared on a farm, had no liking for agricultural pursuits, and in his early life did not expect to become a farmer. On the other hand, his desire was to become a civil engineer or a mechanician, but through force of circumstances he drifted into farming on the land which his father and his grandfather had tilled before him. He was denied the privilege of more than a common-school education and was forced to begin farming under many handicaps. He took up the problem with characteristic energy, however, and the results of 18 years of his management are set forth in the following pages. This account is offered as evidence of what can be accomplished by applying systematic methods to the farm and by thorough organization of the business. These two factors, businesslike methods and organization, are the ones which stand out in the history of this New York farm. A measure of what has been accomplished may be found not only in the success of the farm itself but also in the fact that the owner has been called to the management of the demonstration farms of a large railroad company.

NOTE.—A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.

HISTORY OF THE FARM.

The farm, which then consisted of 57 acres of land, was purchased in April, 1892, for $5,000. It was necessary to give a mortgage of $3,000 upon the place at the time. The purchaser had a wagon, a single carriage, a sleigh, harnesses, three horses, one cow, and some other equipment. He was obliged to go in debt to the extent of about $250 for such other necessary tools as plows, harrows, drags, a potato digger and planter, a weeder, and a hand cultivator. In addition to this, his note was given for three cows. The buildings on the place were fair to good and very much the same as they are at the present time. The fences were constructed of rails and stone; at least one-fourth of the farm was waste land, swamp, pasture, etc. (Figs. 1 and 3.)

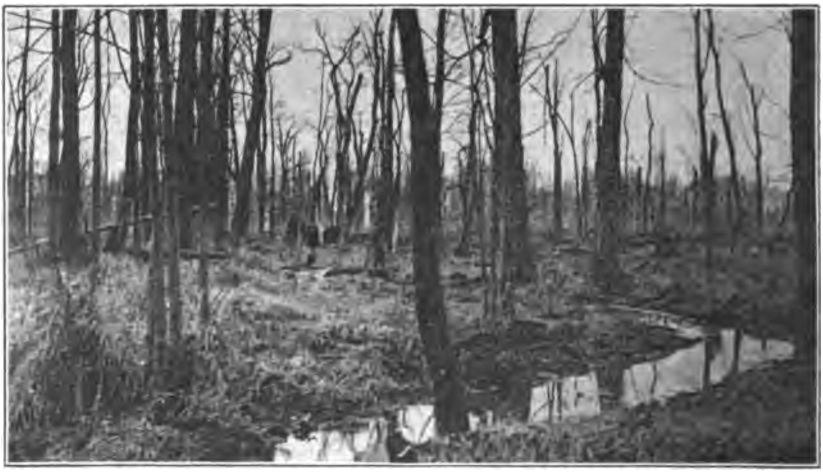

FIG. 1.—A part of the farm in 1892, showing its unimproved condition at that time.

The task of the first few years was to clear away the old fences and to divide the farm into fields of more regular shape. The last fence went in 1900. Probably 1,200 yards of stone have been removed from the land and fence rows during 17 years. Several hundred stumps were removed during the first six or eight years, and this, together with the removal of the stone, added considerably to the available tillable area. The drainage, which was begun very early, also added more tillable land. An account of this drainage will be given later.

The first few years was a period of constant struggle under most discouraging conditions. The income from the farm was scarcely sufficient to pay the expenses and the notes which were given for equipment at the time of beginning farming operations. From time to time it was necessary to add to the equipment, and other notes had to be given; for example, $235 for two horses in 1893. The income from the butter made from three cows, together with the egg money from the chickens, was mostly required to keep the family in groceries and other household necessities. If these funds purchased the clover seed in addition the owner considered himself fortunate. Potatoes formed the real money crop from the first and, together with some wheat and buckwheat, were the chief source of income.

From 1892 to 1900 extremely low prices prevailed, forming a great handicap to successful farming and farm improvement. During this period potatoes sold as low as 8 cents a bushel, wheat as low as 48 cents a bushel, rye 32 cents a bushel, eggs 10 cents a dozen, butter 13 cents a pound, and lard 6 cents a pound, these figures being taken from the owner's books.

These were times when small failures or successes counted for much; when, for example, the failure of a hatch of chickens meant curtailing the grocery bill and when a shortage in the potato crop meant failure to meet notes which were pressing to be paid. But the owner never lost sight of the ideal which he had in mind, and every effort was bent toward increasing the area devoted to the money crop and increasing the yield of every acre of this area. A systematic rotation of crops was early adopted and the fertility of the soil was not only maintained but increased. It was not long before this policy began to count. Each year saw a little more of the debt wiped out and a little more added to the equipment of the farm and hence to its productive power. These methods were continued until the indebtedness was entirely paid, the drainage system on the farm completed, and many comforts and conveniences added to the farm.

ORGANIZATION OF THE FARM.

The one thing which stands out above all others on this farm is its thorough and complete organization for business. A rotation of crops was begun at the very first. This consisted of wheat, followed by clover and timothy, mostly the latter, fodder corn, potatoes, and buckwheat. At first this rotation was more or less irregular, but an effort was made all the time to get the fields into shape for a fixed four-year rotation. This was begun about 1895. It consisted of (1) rye, (2) clover and timothy hay, although the clover did not catch well at this time, (3) potatoes followed by rye, which was plowed under in the spring and followed by (4) potatoes again. This rotation was intended to be the ultimate one, but as it failed to maintain the potato yields it had to be abandoned. Rye was used in this rotation until 1898, when wheat was substituted on account of its larger yield and higher price. In 1899 the rotation was shortened to three years and made the simple one of wheat, clover, and potatoes. By this time the farm was pretty well cleared of stumps and fences and the whole thrown into three large fields where the three-year rotation was regularly and systematically followed. (Figs. 2 and 4.)

The direct result of these business methods of organization was a farm with definite fields, a definite rotation carefully followed every year, and a complete drainage system. This result did not come about in any casual manner, but was brought about entirely by a well-developed plan systematically followed from the very first, being modified as circumstances demanded.

When the farm was well organized and making good returns, attention was turned to that part of the business which, while it did not show as large returns from a dollar standpoint, still added very much to the efficiency, convenience, and comfort of the owner and his family. One of the most complete sets of small tools for the repairing of farm equipment which was ever brought together on a farm was collected and systematically arranged. This has proved to be of the greatest value in the repairing of farm equipment and in the making of various minor but necessary articles on the farm. The garden was the next part of the business to receive attention, and this was as systematically organized and planned as if it were yielding a large income in cash. These two items of the organization will be dealt with in more detail in the latter part of this bulletin.

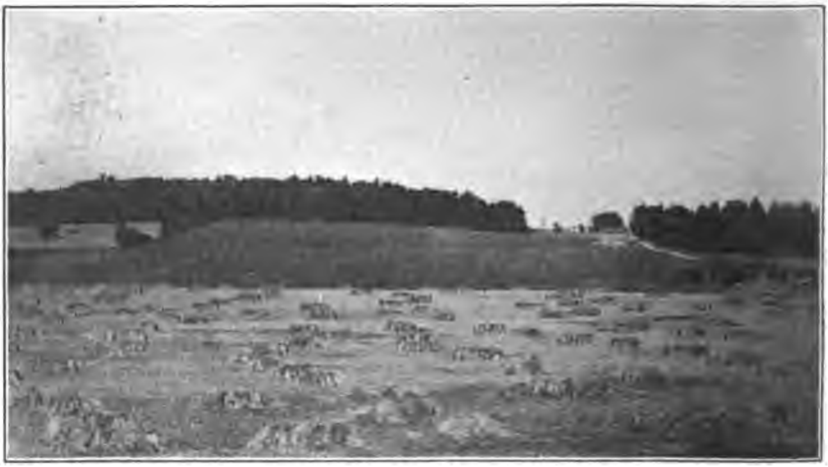

FIG. 2.—The farm as it appeared in 1908, showing wheat in the foreground, next clover hay, with potatoes in the background. The left side of the wheat and clover fields is identical with the location shown in figure 1.

The most remarkable thing about this farm is not that any one of the many things has been done so well, but that so many things have been done well. It is very unusual to find a farmer who, without much capital, has made a model garden and orchard which would do credit to a man of wealth, assembled a model small-tool equipment, put in an excellent tile drainage system, and who at the same time has grown nearly maximum crops and made a good profit or interest on his investment.

DRAINAGE.

Probably the most important factor in the increased productiveness of this farm is the thorough system of tile drainage which has been put in operation. The soil, which varies from a loam to clay loam and gravel loam (Dunkirk series), with a stony clay and hardpan subsoil, lies partly on a gentle eastern slope and partly on a rather level area bordering a small stream which runs through the farm. About half of the land has fairly good surface drainage and the other half poor to very poor. (Figs. 3 and 4.) In these respects it did not differ materially from many other farms in the neighborhood and throughout this section of the country.

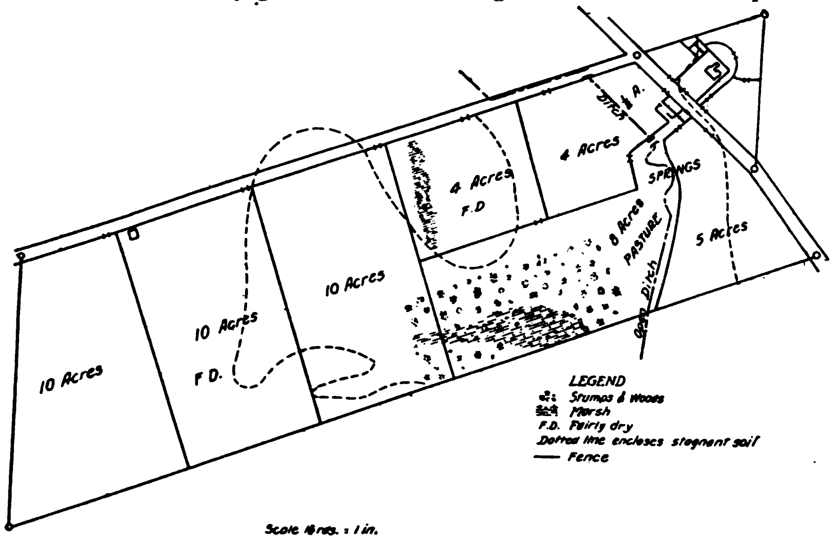

FIG. 3.—Diagram of the farm as it appeared in 1892, showing the location of the fields, etc.

In 1892, when the place was purchased, some 2 miles of stone drain had been laid. The drains were very shallow, however, and were mostly stopped up. In 1894, while the owner was still heavily in debt, tile draining was begun, and during that year about 2 miles were laid. It was necessary to give a note for the carload of tile which was used in this first drainage. The owner's friends began to doubt his sanity. Probably $250 altogether were expended in this drainage during the first year. In 1895, 2 additional miles of tile were laid. This year the potato market went to pieces, potatoes selling as low as 15 cents a bushel, and in 1896, with neither money nor credit, it was impossible to continue the drainage. That year attention was turned to stump pulling and the clearing of waste land. The next year, however, the drainage was resumed and 200 rods of drain were laid, making a total of 1,400 rods. Between 1898 and 1909 the general plan of laying as much drain as possible during each year was followed. At the present time there are 3,200½ rods, or one-half rod more than 10 miles of drain, on the 57.85[1] acres which now comprise the farm. (Fig. 5.)

From the very first, a complete system of drainage was planned for the farm and, while the tile first laid were put in the lower parts of the farm where drainage was most needed, the future development of the system was kept in mind and large sewer pipes were used so that these could later serve as mains in the system. As early as 1897 and 1898 a systematic plan of drainage was outlined for the farm and was thereafter followed.

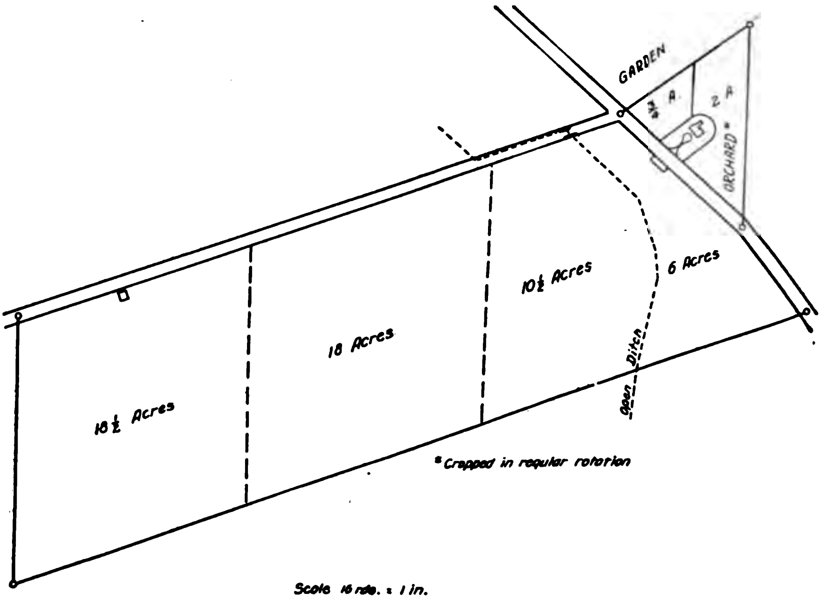

FIG. 4.—Diagram of the farm in 1908, showing the location of the fields, etc., after reorganization.

The draining was usually done on plowed land where potatoes were to be planted. If it was not possible to do it in the fall or the following spring before planting, the tile were laid right through the potato field later in the season. It was the practice to locate a pair of drains, side by side or alternate ones, and set a line of small stakes over them. A man with a team then opened a dead furrow, which was shoveled out, the ground replowed, and the furrow reshoveled until 2 to 2½ feet deep. The remaining depth was dug by hand, using modern drainage tools, such as 18-inch drain spades, narrow cleaning shovels, double-end tile scoops, pickaxes, etc. The lateral drains are usually 55 feet apart and preferably 4 to 4½ feet deep. The plowed portion of the ditch was about 18 inches wide, but the remainder was narrowed down to tile size. The soil removed from this pair of drains was thrown out on the left bank of one and the right bank of the other for economy in plowing in, the team going up one side and down the other. After the tile were laid and the joints carefully covered, the ditch was filled in with a plow. The tile used in the system vary from 3 to 12 inches in diameter, the main for the west-side system being 8 inches in diameter.

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[1] A small strip of land, 0.85 of an acre, was purchased in order to enlarge and perfect the shape of the garden and orchard.

A fair estimate of the cost of laying the tile in this system under average conditions is 50 cents per rod, including the tile and the labor of laying. Figuring the owner's time at $2.50 a day and day labor from $1 to $1.50, the tile at $12 to $15 a thousand for the 3-inch size, etc.,

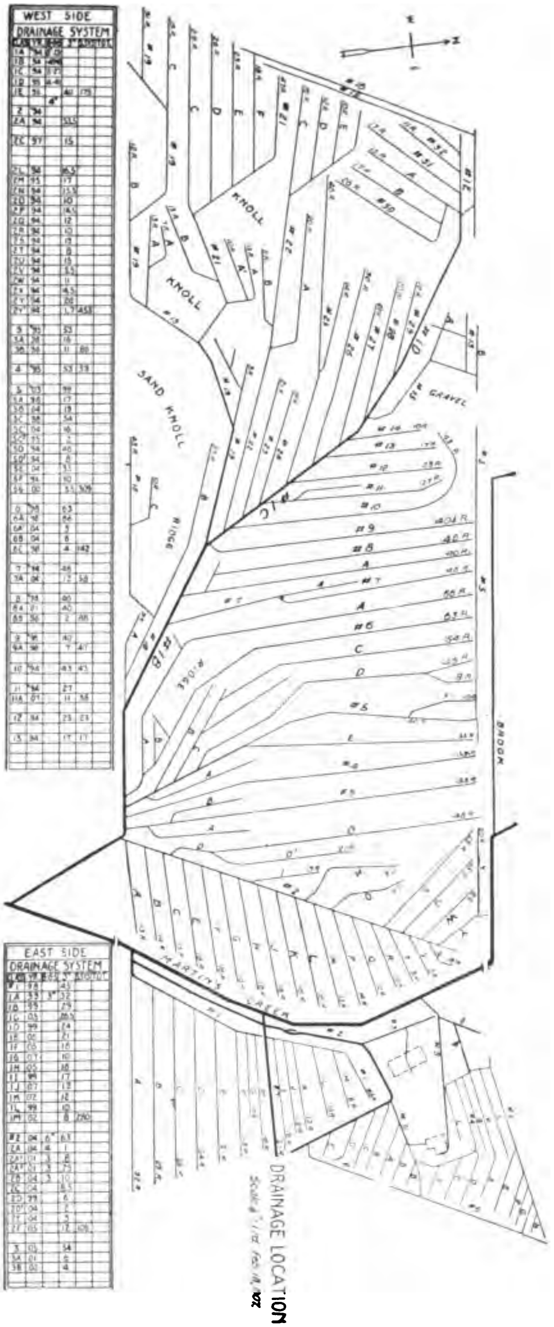

FIG. 5.—Drainage map of the farm, showing the location of all drains. The key shows in part the size and location of tile, with date of laying.

brings the probable cost of the system up to about $1,600. Some extra work, such as cutting through a knoll, added $400 more. In addition to this, the cost of obtaining an easement through adjoining property and the digging of a 4½-foot ditch through marsh and woodland, 233 rods in length, for an outlet was about $500, so that approximately $2,500, or half of the original cost of the farm, has been expended in tile drains in 15 years. In addition, this outlet ditch has to be cleared out every year at an average expense of about $50 a year.

Probably the most convincing argument and the best proof of the value of drainage is the presence of flourishing, nearly maximum crops on land that was formerly sour, boggy, and marshy. This is well illustrated in figure 2.

CROPPING SYSTEM FOLLOWED.

As previously stated, the rotation now followed is the simple one of wheat, clover, and potatoes. This has several advantages. In the first place it is a short rotation, each of the crops coming once in three years on the same land. Then the potato crop is a strong money crop, the wheat a fairly good one, and the clover an excellent crop for maintaining fertility. Moreover, it is necessary to plow but once in three years. Perhaps the greatest difficulty with this rotation is that in some years the potato crop is so late in harvesting that it is not practicable to get the wheat in early enough to get sufficient growth to carry it safely through the winter, and the wheat crop is often light on this account. The table on page 13 shows that there is a direct relation between the date of seeding and the yields, earlier seedings giving better yields than later ones.

The clover is sown in the wheat in the spring and covered with a spike-tooth harrow. The first crop of clover is harvested and fed to the work horses and the two cows. The second crop is usually mowed and left on the ground. This crop, together with the later growth, is plowed under in the fall. Potatoes are put upon this land the third year, the aim being to plant as early as possible in the spring so as to get a crop off in time for wheat.

WHEAT.

PREPARATION OF THE LAND.

The wheat crop follows potatoes. As soon as the potatoes are harvested the vines are raked up with a hayrake and burned. In order to make a clean job, the field is first raked lengthwise and then across. When the field is clean, a double-action cutaway harrow is run straight or diagonally across the potato rows. This harrow is the 7-foot size, has twenty-eight 16-inch disks, and requires four horses. The spring-tooth harrow is then run diagonally over the field to level the ground, concluding the preparation.

SOWING.

The sowing is done at right angles to the prevailing winds, so that the rows may catch and hold the snow. A grain and fertilizer drill with hoes 7 inches apart is used. The variety of wheat sown is Klondike, a white, beardless wheat with a stiff straw. The date of seeding has varied from October 1 to October 30, rather later than most seeding in this section. For the last 12 years the average date has been October 13.

HARVESTING.

The grain is cut with a self-binder having a 6½-foot cut and is shocked in the field. Harvesting is not begun until the grain is dead ripe. As soon as the berry is dry it is thrashed in the field after the western method, being hauled directly from the shock to the machine. The straw is stacked in the field; the grain is drawn to the barn and sometimes sold immediately, sometimes held until later in the winter, depending on the condition of the market. No straw is sold from the farm. What is necessary for the bedding of two cows and four horses is hauled to the barn; all the rest is spread on the hay stubble in the fall and plowed under for potatoes the following year.

YIELDS.

The yield of wheat is usually dependent upon how early the potato crop of the previous season is harvested and upon the succeeding winter. Because of the lateness of seeding the average yield is not usually large, being 25⅗ bushels per acre for 12 years. In the fall of 1908 the wheat was sown about October 1, and the yield in 1909 was 45 bushels per acre from the entire 18 acres. In 1909 wheat was sown October 14 and yielded 34 bushels per acre in 1910. The yield for the last six years averages 5⅕ bushels per acre greater than that of the previous six years. Table I presents in a convenient form the facts as to date of sowing and yield to the acre for 12 years.

TABLE I.—*Yields of wheat on the farm for 12 years, 1899 to 1910, inclusive.*

Years.	Date of sowing, previous fall.	Acres.	Yield per acre.[1]	Years.	Date of sowing, previous fall.	Acres.	Yield per acre.[1]
			Bushels.				*Bushels.*
1899	Nov. 4	18¼	8.1	1905	Oct. 19	18	24.7
1900	Oct. 10	18	18.8	1906	Oct. 7-13	18	22.7
1901	Oct. 6	18	18.0	1907	Oct. 16	18	24.3
1902	Oct. 8	18	34.0	1908	Oct. 19	18	18.3
1903	Oct. 3	18	40.0	1909	Oct. 1	18	45.0
1904	Oct. 17	18	19.0	1910	Oct. 14	18	34.0
6-year average			23.0	6-year average			28.2

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[1] Average for 12-year period, 25.6.

CLOVER.

SEEDING.

Two quarts of timothy are sown at the time of the wheat seeding in the fall. Formerly 7 quarts were used, but since clover has become a more certain crop the proportion of timothy has been decreased. The greatest care is used to get clean seed, and no expense is spared to procure the very best. In the spring the clover seed is sown. The quantity used prior to 1907 was about 17 pounds per acre, somewhat less than now, the tendency having been to increase the amount of clover sown each year. In the spring of 1907 alfalfa was added to the clover. That year 20 pounds of clover and 6⅔ pounds of alfalfa were sown per acre. In 1908 and 1909 the seedings were the same, being the first use of alfalfa on each of the fields in rotation. In 1910 (beginning the second cycle of the rotation since alfalfa was first sown) the seeding was 15 pounds each of clover and alfalfa. In the third cycle (1913) the seeding will be three-fourths alfalfa and one-fourth clover, the idea being to substitute alfalfa entirely for clover in this rotation by the time the fourth cycle (1916) of the rotation is reached. The seed for the 18-acre field, which in 1909 was 6½ bushels of red clover and 2½ bushels of alfalfa, was divided into 18 equal parts and each acre's portion was separately and thoroughly mixed in a metal bushel basket. Care was used to see that each acre received its proportionate quantity of 30 pounds, this being carried to the field in a separate bag.

The seed was sown in the wheat field with a broadcasting seeder which covers four drill widths at a passage. The usual time of seeding is between April 1 and 10, and is determined by the conditions. The most favorable time is thought to be when the ground is fairly dry, preferably in the afternoon when the surface is most opened up by evaporation, The next forenoon the ground is harrowed with a lever-set, sharp, spike-tooth harrow, the teeth being set straight. Each section of this harrow weighs about 100 pounds. Preferably the harrow is run across the drill rows in order to cover the seed as well as possible. Great emphasis is placed on the complete covering of seed and no pains are spared to do this. Formerly seeding was done on a honeycombed surface cracked open by frost in the early morning, but it was later found that this condition was prevented by drainage and that the seed did not germinate well, owing to its not getting into the soil.

After wheat harvest the wheat stubble is clipped about 3 to 4 inches high with the mower with the swathing board removed, and the stubble is left on the ground. This gives the young clover plants their best chance to grow and destroys the weeds, especially the ragweed.

HARVESTING.

The mowing machine is started in the field between June 15 and 20. It is expected to have the hay in the barn before July 1, and preferably by June 25. As the alfalfa comes more and more into the rotation the hay will be cut still earlier.

UTILIZATION OF THE CROP.

When a big crop is grown it is cut high and as much of the stubble left as possible. The crop is fed out to two cows, which are stall-fed the greater part of the year, and to the four work horses. In addition, the horse of a friend is kept in hay and straw and the manure hauled back to the farm. The second crop of hay is sometimes cut and hauled to the barn to sell if the price is high, but usually it is cut and left on the ground. A second crop is never removed from the poorer parts of the field. This second cutting is usually made about the first week in August; about September 15 the third cutting is made and left on the ground. This is done because it rots more quickly and because some weeds are prevented from going to seed.

YIELDS.

The yields of hay, of course, vary greatly with the season, but the stand of clover is uniformly a good one. In fact, for the last two years it has been as good as the writer has ever seen anywhere. In 1901 and 1905 the clover averaged 4 tons of cured hay per acre. In 1907 the yield was not quite 2 tons per acre, while 56 tons were cut from 18 acres at the first cutting in 1908. Some hay is sold when the crop is large if there is any surplus, although the quantity sold seldom exceeds $100 in value.

POTATOES.

PREPARATION OF THE LAND.

In preparing the land for potatoes all the third growth and sometimes the second growth of clover, especially on thin parts of the field, is left on the ground. In addition to this, all the wheat straw except what is used for bedding for the stock is spread on the clover sod in the fall. What manure is made is drawn after haying and spread on the thinner parts of the clover field. All this material is plowed under in the fall. Spring plowing is preferred, but for the last two years, because of economy of time and because of a better rotting of the straw plowed under, fall plowing has been practiced.

In the spring a spring-tooth harrow is first run over the ground, going with the furrows. After this a cutaway harrow is used diagonally across the field in each direction and again at right angles to the furrow, three times in all. The spring-tooth harrow is then used diagonally across the field to level the surface. One application of fertilizer is made with the grain drill, preferably between the first harrowing and the first time over with a cutaway harrow. The second application is made just before planting. Going over the field twice with a grain drill in this way serves also as cultivations. The roller is used ahead of the planter to insure a uniform planting depth. Any rough or lumpy parts of the field are given extra harrowing and rolling.

SELECTION OF SEED.

A seed plat of about 2 or 3 acres is grown annually in order to provide the next year's seed supply of potatoes. This plat is put on the best part of the field and where the land is free from scab. The product of this plat is ordinarily about 900 bushels, which are assorted into two grades, "selects" and "specials." "Specials" must weigh not less than three-fourths of a pound each and must have well-developed seed and stem ends, and they must be true representatives of the type and variety, which is exclusively Sir Walter Raleigh. The "selects" are those which do not pass this test, except tubers which are poor in shape or below size, which are discarded and used for food. About 10 days before the potato tops die this plat is carefully gone over and all diseased, dead, poor, or otherwise imperfect hills are dug up and removed from the seed plat. "Specials" are used to plant the seed plat the following year, and these are all treated with formaldehyde. The "selects" are planted in the remainder of the field.

PLANTING.

An automatic planter which opens the furrow, cuts the seed tuber into four pieces, drops and covers each piece, and marks the next row is used for planting. This machine requires one man to drive and another man to feed the seed into the hopper. Potatoes are planted 3 to 4 inches deep, 11 inches apart in the row, with the rows 36 inches apart. Each seed tuber is of marketable size, and about 22 bushels are required to seed each acre, but one piece being used in each hill.

FERTILIZATION.

In 1909 between 1,500 and 1,600 pounds of a home-mixed fertilizer, which analyzed 3.89 per cent nitrogen, 8.33 per cent phosphoric acid, and 13.33 per cent potash, were applied, 1,000 pounds to the acre at the first application and from 500 to 600 pounds at the second. The source of the nitrogen in this fertilizer is nitrate of soda, dried blood, and fresh ground bone. The source of the potash is the sulphate, while that of the phosphoric acid is ground bone and rock. The quantities used, with the percentage of each, are shown in Table II.

Table II.—*Quantities of home-mixed fertilizer used for each acre of potatoes, with the percentage of nitrogen, phosphoric acid, and potash it contained and the source from which each constituent was derived.*

Fertilizer constituent.	Fertilizing material.		Fertilizer constituent in material used.	
	Source.	Pounds used.	Per cent.	Pounds.
Nitrogen	Nitrate of soda	4,000	15.8	632
Do.	Dried blood	4,000	9.8	392
Do.[1]	Fine, pure ground bone	6,000	2.4	144
Phosphoric acid[1]	do	6,000	23.1	1,386
Do.	Treated rock	8,000	14.0	1,120
Potash	Sulphate of potash	8,000	50.0	4,000
Total		36,000		7,674

[1] Counted but once.

The ingredient materials shown in Table II are mixed together at home on the barn floor with a shovel at an average cost of about 50 cents per ton. A total of about 28,500 pounds was applied to 18 acres, 1,500 pounds being used on the garden. In 1909 the cost of these ingredients, f. o. b. the farm, was $34.18 per ton, or $25.63 per acre. The quantity of commercial fertilizer used is being reduced each year, as the great improvement of the farm in fertility makes its use less necessary. In 1910 only 1,200 pounds were used and the yield was above the average.

CULTIVATION.

The cultivator is started in the potato field within a week after the beginning of planting, the teeth being set wide apart and the potato ridges followed as a guide. The object of this cultivation is to break up the middles between the rows which have been pressed down by the roller, by the horses, and by the wheels of the planter. For this cultivation straight teeth 2¼ inches in width are set at a depth of about 3 inches. A week later a second cultivation is made, a smaller number of the same kind of teeth, set at a depth of 5 to 6 inches, being used. At least two cultivations are made before the potatoes are up, care being taken to keep away from the potato row so as not to disturb the tubers. A 2-row pivot-wheel riding cultivator is used. After the third or fourth cultivation, or as soon as the potatoes are well up, a weeder is run over the rows crosswise and again lengthwise. This last time over, the weeder pulls the plants straight into the row and facilitates cultivation. During the third and fourth cultivations the machine is adjusted with 1¼-inch teeth next to the row in order to do close work. The other teeth are set the same as at first. At the fifth cultivation, 7-inch side steels throw a small, sharp ridge of soil directly on the potato row and the soil next to the row in order to bury and smother any weeds escaping previous cultivations. The spike-tooth harrow which was formerly used to clean out these weeds was found to be too rough on the plants in this soil. All the remaining cultivations (there are usually 10 or 12) are made with the same teeth as are used in the fifth, gradually widening the space next the row as the vines develop. A tooth set ahead of the gang bar on each side prevents the wheels from running on the plants. Two hand weedings are made during the season, one about July 15 and the other about August 25, in order to get any weeds which may have escaped the cultivator. The ground is so clean that a man can pull the weeds on from 1 to 4 acres in a day.

SPRAYING.

Spraying is a very important item in the growing of a crop of potatoes on this farm. The watchword is thoroughness. The sprayer used is a 2-wheeled, 1-horse, homemade affair.[1] The power is supplied by a double-acting force pump having a large air chamber and equipped with a relief valve, pressure gauge, revolving agitator, etc. This pump develops and maintains 75 pounds of pressure, which the relief valve regulates. Unless otherwise desired, the sprayer covers six rows at a time and six Bordeaux nozzles are brought to bear, one on each row. Two central nozzles spray backward under the machine; all the rest are directed ahead. The nozzles are so arranged that the operator can adjust them from his seat without stopping the machine. The balance of the machine is secured by placing the tank over and a little back of the axle. The operator's seat is on the tank.

The 5–5–50 Bordeaux formula [2] is used, but the particular strength of the mixture is not regarded as being so important as that it is applied vigorously, liberally, and on time. Paris green is the insecticide used, and is applied at the rate of 1½ pounds per acre. None but chemicals with a guaranteed analysis are purchased. Stock solutions of copper sulphate and of lime water are kept in readiness. The tank is filled from the small stream which runs through the farm. The mixture is always tested before being applied, and an excess of lime is used. Emphasis is laid upon having the material well mixed.

As a rule each application is made in opposite directions on the rows or, if an application is made in only one direction, the next time over it is made in the opposite direction. During the first spraying the nozzles are directed downward in the center of the row at an angle of 45 degrees. Before the rows meet, usually in mid-July, the nozzles are swung to the left and downward at the same angle. Next, the nozzles are swung to the right and downward. Again, the nozzles are set straight and downward at an angle of 45 degrees. The owner says that "this plan requires three double or six single opposite applications to complete the cycle and gives the operator the important advantage of getting at the potato plant—attacking the enemy from six different positions or angles, thereby forcing the copper plating on every part of the potato plant from top to bottom."

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[1] In 1910 a modern, 2-horse, 100-gallon machine was purchased.

[2] Five pounds of copper sulphate (blue vitriol) and 5 pounds of lime to 50 gallons of water.

In 1908 the first application of spray was made on June 23 and the the last on September 4. During the five weeks following the middle of July, the period of maximum growth, 125 to 150 gallons of Bordeaux mixture per acre were applied each week. The owner believes thoroughly in frequent and light applications, and points out that an acre of good potatoes at maximum growth makes from 2 to 3 or more acres of vine and leaf area during this period.

The extent of spraying done may be considered excessive by many, but the owner has found in a careful test that it pays. He has secured a good profit from the sprayed rows over the unsprayed rows. We will let him give these results in his own words, as recorded in the Rural New Yorker of May 22, 1909:

> According to carefully conducted tests the past season, the central row of a three-row check (not sprayed) yielded at the rate of 137 bushels potatoes per acre. Sprayed potatoes adjoining, where 1,427 gallons of Bordeaux were applied per acre, yielded 240 bushels of better stock—an increase of 103 bushels by spraying, and the total cost was $13 per acre. Some may say this is excessive, but a further test was made. Two separate rows were double sprayed, or 2,854 gallons of Bordeaux were applied, and the yield in each case was 278 bushels per acre. The spraying cost double, or $26 per acre. The increase was 38 bushels, which cost $13. This paid too, both in satisfaction and from a business standpoint. Figuring our annual 18 acres at 103 bushels per acre increase from spraying, at 60 cents per bushel,less cost of spraying, a net profit of $878.40 would be realized. Does it pay? For several years similar tests and results have been made and realized.

DIGGING AND MARKETING.

A digger is used in harvesting the tubers (fig. 6). The potatoes are picked up by men and boys into bushel crates, which are manufactured on the farm from purchased timber sawed at a nearby mill. In an average year from 12 to 15 pickers will keep up with the digger and haul each day's digging to the cellar. In the early days 150 bushels were regarded as a good day's digging, but now, with improved machinery and methods, 1,000 to 1,200 bushels are handled in a day. On one day in 1906, 1,500 bushels were dug, picked, and hauled—1,000 bushels 1 mile to the station, the remainder to the barn. Twenty-three pickers, including 10 girls and boys, were required to do the work. The tubers are stored in the house cellar as far as possible, particularly the seed-plat stock. This cellar holds about 2,500 bushels. The barn is used to store the remainder of the crop; stock stored in the latter place must be removed before the temperature goes lower than 20° F.

COST OF GROWING.

Some will undoubtedly think that the cost of growing potatoes on this farm is excessive and that there is no profit when so much expense is entailed. The following is a careful estimate made by the owner of the farm and the writer, which shows a net profit of $39.33 per acre, or 14 cents per bushel, besides 6 per cent interest on the land and equipment. This estimate is based on expenses during the last three years, which are a little high for the whole nine-year period, and on the average yield and price for the last nine years.

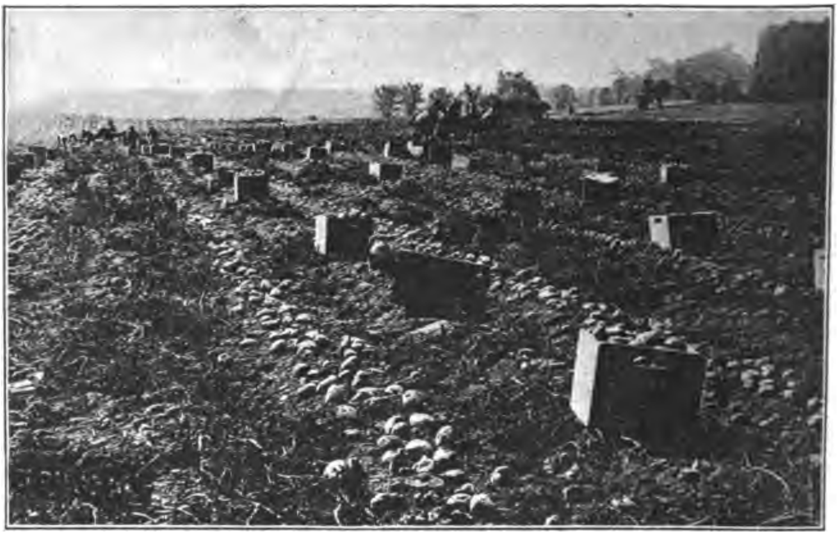

FIG. 6.—Potato harvest on the farm, showing the digger in operation and pickers at work.

TABLE III.—*Cost per acre and per bushel of growing potatoes on the farm for the nine years, 1901–1909.*

Items of expense.	Cost per acre.		Cost per bushel.
	Separate items.	Total.	
			Cents.
Plowing	$3.00		
Preparation of land	2.00		
Planting	1.00		
Cultivating (14 times)	6.30		
Spraying	6.30		
Harvesting	7.00		
Marketing	3.00		
Cost of labor		$28.60	10.2
Seed (22 bushels at 42.4 cents)	9.32		
Fertilizers (1909 figures)	25.63		
Spraying material (1908 figures)	6.00		
Use of equipment ($28 per acre at 6 per cent)	1.68		
Interest (6 per cent on land, $150, or rental value)	9.00		
Cost of seed, fertilizer, equipment, etc		51.63	18.2
Total cost		80.23	28.4
Receipts		119.56	42.4
Net profit		39.33	14.0

INCOME.

The income from the potato crop is an interesting feature of this account, because it is more or less the measure of the success of the methods practiced. The following table gives the total and average yield per acre for 18 years. During the first 9 years the crop averaged 132 bushels per acre. In 1900 drainage and better methods began to make themselves felt and the yield steadily increased. During the last 9 years the annual average from 18 acres has been 282 bushels per acre. This is an increase of 150 bushels per acre for the last 9 years over the 9 years from 1892 to 1900. During the last 5 years it has averaged 295 bushels per acre. The average yield for the whole 18 years, during which 373 acres have been cultivated and 73,558 bushels have been grown, is 197 bushels per acre. In 1910 the yield was 328 bushels per acre, which was considerably above the average and shows that the farm is still improving. Good farming tells.

TABLE IV.—*Potato yields for 18 years on the farm.*

Years.	Acres.	Yield in bushels.		Years.	Acres.	Yield in bushels.	
		Total.	Average per acre.			Total.	Average per acre.
1892	12	1,200	100	1901	18	4,570	254
1893	25	2,525	101	1902	18	4,680	260
1894	26	3,063	118	1903	18	4.718	262
1895	22	3,065	139	1904	18	5,090	283
1896	30	4,186	140	1905	18	4,825	268
1897	30	3,500	117	1906	18	7,510	417
1898	30	5,180	173	1907	18	5,425	301
1899	18	2,353	131	1908	18	4,200	233
1900	18	2,868	164	1909	18	4,600	256
9-year average, 1892–1900	211	27,940	132	9-year average, 1901–1909	162	45.618	282
				18-year average	373	73,558	197

LIVE STOCK.

This farm is a good example of the maintenance of fertility with the use of a very few live stock, only six head being kept on 58 acres, or about one to each 10 acres. The two cows, which are Jerseys, are stall-fed on clover hay. They are fed 5 quarts of bran and corn meal, equal parts by weight, twice during each day except in the summer. During the winter and until May 1 they are also fed beets twice a day. From 150 to 300 bushels of beets are grown for this purpose. During the summer the cows are staked out on a part of the meadow or the roadside. These two cows supply the milk and butter for the family and considerable to sell besides.

The team work on the farm is done by four horses, which average about 1,300 pounds each. These horses are never pastured, but are kept up in stalls the entire time. During the working season they are fed, in addition to clover hay, 6 quarts of oats three times a day, 350 bushels of oats being purchased each year and ground at the mill for this grain ration. During the winter the horses receive no grain, but only clover hay.

LABOR.

The work on this farm is performed by two men, one of whom receives $32 per month for eight months, $20 for December, $10 per month for January and February, and $20 for March, together with board. The other man is employed for eight months at $1.50 a day and board. In addition to this, extra day men are hired as needed. They are mostly required in potato harvesting. The owner is a hard worker and does a large part of the work on the farm himself. He attends personally to all such work as the seeding of clover and the planting and spraying of potatoes. This has been the case until the past year, 1910, when he removed from the farm to take charge of the farms of a railroad company. Now a manager is employed to take the owner's place. The other labor remains the same.

THE MEASURE OF SUCCESSFUL FARMING.

The average farmer is altogether too prone to measure success in farming entirely from the dollars and cents standpoint. A good net income is but one of the factors of success on a farm. A comfortable home, convenient and efficient buildings and equipment, and more fertile and productive land are certainly equally important factors. Successful farming may be defined as that which gives maximum cash-crop returns, ordinary home comforts and conveniences, efficient economic administration, and at the same time leaves the land in an increased state of fertility and productiveness. Let us see how this farm measures up to this standard.

THE FARM INCOME.

A complete table of the income for each of the 18 years during which the present owner has operated this farm follows. In this table it appears that the average total receipts for the nine years from 1892 to 1900 were $1,094.40, made up as follows: Potatoes, $861.52; wheat, $73.37; hay, $17.62; butter and eggs, $76.83; and miscellaneous, $65.06. Compared with this is the average income during the nine years from 1901 to 1909, which was $2,786.33, made up of potatoes, $2,115.82; wheat, $258.53; hay, $60.61; butter and eggs, $71.94; and miscellaneous, $279.43. Some remarkable increases are shown. The potato income[1] increased 145 per cent, the wheat income 252 per cent, and the total income 155 per cent. The income from butter and eggs remained about the same, but the income from miscellaneous sources was increased four times, principally due to the sale of orchard and garden products. The amount of the income is not so remarkable as the increase of the last nine years over the preceding nine years.

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[1] A factor in this greatly increased income from potatoes has undoubtedly been the increase in the average price of potatoes. From 1892 to 1900 the price ranged from $0.095 in 1895 to $0.509 in 1897, and averaged $0.292 per bushel. From 1901 to 1909 the price ranged from $0.273 in 1904 to $0.578 in 1908, and averaged $0.424 per bushel. The selling price for the last 9-year period averaged $0.132 more per bushel than the preceding 9-year period. The average price for 18 years is $0.358 per bushel. Much the same is true of wheat prices.

TABLE V.—*Sales of produce from the farm, 1892–1909.*

Year.	Potatoes.	Wheat.	Hay.	Butter and eggs.	Miscellaneous.	Total.
1892	$497.30	$68.51	....	$121.56	$90.00	$777.37
1893	895.44	73.00	....	207.96	44.50	1,220.90
1894	811.31	[1] 41.56	....	101.96	20.93	975.76
1895	291.77	[1] 21.50	....	86.77	15.00	415.04
1896	493.17	[1] 51.00	....	43.85	117.00	705.02
1897	1,781.00	[1] 80.00	....	26.16	150.00	2,037.16
1898	1,469.91	97.53	....	25.28	50.00	1,642.72
1899	796.80	48.34	$113.83	47.42	55.14	1,061.53
1900	717.00	178.92	44.74	30.54	42.86	1,014.06
9-year average	861.52	73.37	17.62	76.83	65.06	1,094.40
1901	2,214.69	92.22	226.00	27.28	350.00	2,910.19
1902	1,652.48	236.00	78.00	44.42	59.48	2,070.38
1903	2,288.80	404.50	....	37.19	107.50	2,837.99
1904	1,391.26	166.17	17.00	95.20	153.60	1,823.23
1905	2,265.80	236.19	....	54.01	395.23	2,951.23
1906	2,525.00	172.00	48.00	121.75	182.57	3,049.32
1907	2,807.89	156.00	85.47	110.35	393.96	3,553.67
1908	2,428.54	148.68	....	66.58	536.83	3,180.63
1909	1,467.93	715.00	91.00	90.68	335.77	2,700.38
9-year average	2,115.82	258.53	60.61	71.94	279.43	2,786.33
18-year average	1,488.67	165.95	39.11	74.38	172.25	1,940.36

[1] Rye instead of wheat.

Unfortunately, it is impracticable to get as accurate a statement of expenses as we have of receipts. While a daybook has been kept during the whole period of 18 years, the items of expense are so confused with personal, family, and other expenses that they can not be separated without a vast amount of labor. Therefore it has been necessary to resort to estimates. These have been as carefully made as possible, being compared with the items in the daybook for some years, where these are clear.

TABLE VI.—*Expenses of the farm, 1892–1909 (estimated).*

Period.	Labor.	Seed.	Feed.	Fertilizer.	Taxes and insurance.	Spraying material.	Depreciation and repairs.	Miscellaneous.	Total.
9 years, 1892–1900	$400	$50	$100	$100	$30	$40	$100	$60	$880
9 years, 1901–1909	600	75	200	500	40	110	150	100	1,775

It will be noted that while expenses have increased, this increase has not been in proportion to the increase in receipts. During the second 9-year period the average expenses increased $895, or 102 per cent over the average for the first nine years, while the receipts increased $1,691.93, or 155 per cent, during the same period. Thus, the owner's profit, which represents his interest on investment and salary, was $796.93 greater during the second nine years than during the first nine years. To put it another way, allowing the owner a salary of $300 a year, his interest on the investment of $10,000, or about $175 per acre, increased from −0.8 per cent to 7.1 per cent.

The profitableness of this farm may be measured in another way. The owner began with a debt of $3,000 on the land and several hundred dollars on the equipment. All indebtedness has been paid. In addition, a tile drainage system costing $2,500 has been put into operation on the farm. The farm, shop, and house equipments have been increased to the maximum of efficiency. These and other improvements have doubled the cash value of the farm and have left a considerable cash balance in the bank. All this must be credited to 18 years of good farming, which may be called fairly successful financial management.

CONDITION OF THE FARM.

The productivity of the soil has been greatly improved and its physical condition made nearly perfect. The plowing under of so much clover and wheat straw has added no small amount of plant food. Together with the judicious use of commercial fertilizers, the plant food added has probably been somewhat in excess of that removed by crops, thus creating what might be called a reserve fund of fertility. Tile draining and green manures have so drained and aerated the soil that its physical condition could hardly be improved.

The soil is an ideal one for wheat and hay, but is rather heavy for potatoes. Only the greatly improved condition of the soil has made good crops possible. The yield of wheat shows an average increase of 5.2 bushels per acre for the last nine years over the preceding nine years; of potatoes, an average increase of 150 bushels per acre for the same period; and of hay, more than double the previous yields. These crop increases are the best evidence of the increased productive power of the soil, which has probably been more than doubled. Moreover, the farm has just reached this condition of maximum production, and from now on a higher average will undoubtedly be obtained on all crop yields. The farm, rather than a bank, has been the depository of profits and has returned good interest.

THE HOME.

A pleasant and comfortable home is certainly a big asset in any business. This feature has not been neglected on this farm, which contains all the comforts and conveniences of the better farms (fig. 7). In this, as in all the struggles of these 18 years, the farmer has had the efficient aid of a capable, hard-working, and patient wife, to whom should be given a full share of the credit for what has been accomplished.

THE GARDEN AND ORCHARD.

The importance of the garden as a farm asset can hardly be overestimated. Ordinarily, in estimating a farmer's profits we fail to consider that the garden supplies a large part of his living. As a matter of fact, the farmer's income should be credited with the difference in the cash cost of running his family table and that of the man who has no garden. Yet the average farmer's garden does not receive the attention which it should have. All other farm work usually comes first and the garden is neglected. Most farmers will not take the time to care for the garden properly when it interferes with other farm work. Often not more than a few hours' work would be necessary to put the garden in proper condition, when lack of this attention would mean the purchase of vegetables or fruit. The farm garden is a real asset, a productive enterprise, and should be so regarded.

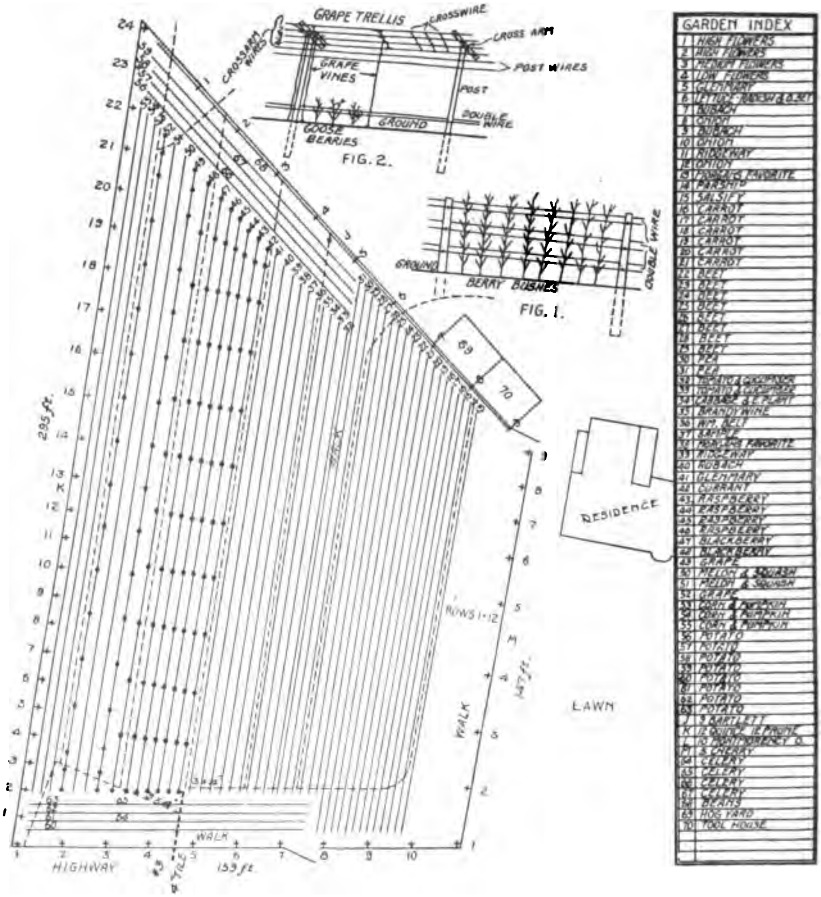
FIG. 7.—House, lawn, and part of the garden on the farm.

On this farm the owner has demonstrated that the garden may not only be made to furnish the family with fruit, flowers, and vegetables during the greater part of the year, but that it may do this without interfering with the regular farm work. In other words, he has proved that a model garden and orchard and maximum crop yields are compatible. Moreover, on this farm the garden has actually returned a cash profit, from $50 to $200 worth of products having been sold from the garden each year for several years.

THE VEGETABLE GARDEN.

In order to give the maximum of efficiency, a garden must be carefully laid out. Reference to the map in figure 8 will show that this one, which is three-fourths of an acre in extent, has been very carefully planned. Each spring each vegetable is assigned a definite row or rows, where it is planted at the proper season. Several hundred pounds of home-mixed fertilizer are applied in the spring and the soil is put in ideal condition to receive the seed. The work is always done on time, if possible, the garden being regarded as a crop as much as the wheat or potatoes. Cultivation is done mostly with wheel hoes and hand tools. It is thorough and persistent. Weeds have no place there and are ruthlessly made war on.

In addition to all such vegetables as are wanted for the family table, considerable quantities of onions for the local market, beets as winter feed for the two cows, and carrots for the horses are grown. These occupy the soil not needed for the regular garden and go far toward paying for the work done in the garden.



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6	LETTUCE RADISH & O.SET
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14	PARSNIP
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17	CARROT
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20	CARROT
21	CARROT
22	BEET
23	BEET
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26	BEET
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48	BLACKBERRY
49	GRAPE
50	MELON & SQUASH
51	MELON & SQUASH
52	GRAPE
53	CORN & PUMPKIN
54	CORN & PUMPKIN
55	CORN & PUMPKIN
56	POTATO
57	POTATO
58	POTATO
59	POTATO
60	POTATO
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62	POTATO
63	POTATO
J	3 BARTLETT
K	12 QUINCE 12 PRUNE
L	10 MONTMORENCY O.
M	5 CHERRY
64	CELERY
65	CELERY
66	CELERY
67	CELERY
68	BEANS
69	HOG YARD
70	TOOL HOUSE

FIG. 8.—Diagram of the garden on the farm, with a partial index of the fruits, vegetables, etc.

SMALL FRUITS.

Fruit forms an important part of this really remarkable garden. All kinds are grown. Cherries and strawberries start the season in mid-June and are followed in succession by currants, black raspberries, red raspberries, blackberries, gooseberries, plums, pears, peaches, prunes, apples, grapes, and quinces. In order not to have any gaps between the different fruits, early, midseason, and late varieties of each fruit were planted. For example, the earliest ripening strawberry on his soil and under his conditions is Glen Mary. This is closely followed by Bubach and Ridgway, Brandywine, the latest variety, closing the strawberry season just as the earliest of the black raspberries are beginning. The same plan is followed with several other fruits. The ground is as fully occupied as possible. Vegetables are grown between the rows of berries where practicable. The raspberries are held up by wires. Grapes are trained on an overhanging cross-arm trellis, and gooseberries, which thrive in the shade, are set under this arbor.

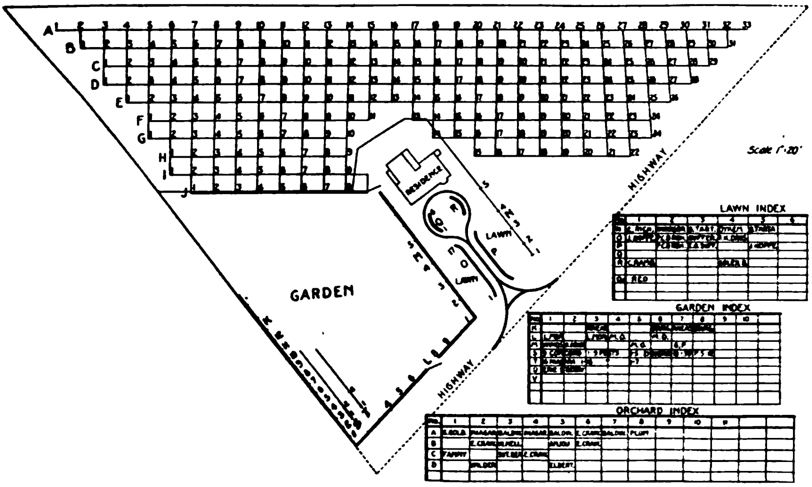

FIG. 9.—Diagram showing the orchard, lawn, and garden on the farm, with an index of each.

THE ORCHARD.

The main orchard as shown in the map (fig. 9) is separate from the garden. It is composed principally of apple trees set 30 by 40 feet apart interplanted with pear and peach trees, thus making the trees stand 15 by 20 feet apart. As with the small fruits, these tree fruits are of many varieties, beginning with the earliest summer apples, pears, and peaches and continuing in succession through the season to the latest varieties. Reference to the keys accompanying the maps will show what these varieties are. They may not be adapted to other soils and conditions as well as to those of this farm. The orchard, which consists of 2 acres of land, has been cropped in the regular rotation up to the present time, the fertility of the soil being maintained in the same way as that of the remainder of the farm.

FLOWERS.

Still another feature of the garden should be mentioned—the flowers. Every year a pyramidal bank of red and white flowers, running the whole length of the garden, is grown. These are arranged in long rows of color, the highest growing flower in the middle, a medium high one next, then a still lower growing one on each side. The aim is so to time the planting that they will bloom together, when they are a beautiful sight.

Thirty varieties of roses [1] are grown in the front yard, which is neatly kept and well arranged. The owner can tell you the name and merits of each of these varieties, as also of the several varieties of peonies growing here. He takes the keenest pleasure in watching and studying these flowers and discussing them with visitors. They contribute no small amount to the sum of enjoyment of life on this farm.

THE SMALL-TOOL EQUIPMENT.

One other department of this farm is worthy of particular mention. In the fore part of this account it was noted that the owner was of a mechanical turn of mind. In following out this liking he has accumulated one of the most complete sets of small tools the writer has ever seen. Mechanic, carpenter, and plumbing tools of every kind which might be of use on the farm, either in making new articles or in repairing old ones, make up this equipment. These include saws, measuring tapes and tools, hammers, wrenches, punches, pliers, braces, sets of bits of different sizes, files, rivets, screws, blacksmith's and woodworker's vises, a foot-power lathe, a forge, an anvil and forge equipment, and many other useful tools. A complete list of these articles with their original cost follows. The inventory totals $332.54, which is probably 25 per cent more than the tools would have cost had they been purchased all together at wholesale rates. Mr. Martin has been accumulating these tools during 18 years and has paid full retail prices for most of them.

In addition to this set of small tools, the repair shop contains a complete set of carriage, machine, and stove bolts in assorted sizes from the smallest to the largest which might be wanted on the farm, numbering 3,303 as inventoried September 1, 1910, and valued at about $35. Besides these, a full supply of bolts, washers, and small parts of the different makes of machines used on the farm is kept on hand. This obviates the necessity of dropping work and going to town after broken or lost parts of implements, which consumes so much time on the average farm.

One afternoon during potato harvest in 1908, when the writer happened to be visiting the farm, an incident occurred which illustrates very well the value of this repair and supply outfit. The short beam of the potato digger was broken in turning the machine. Fourteen men were picking up potatoes, while a team and two other men were hauling. The pickers were not far behind the digger and in half an hour or less would have caught up and been idle. But there was an extra part in the farm shop, and, calling one man to his assistance, the owner quickly unhitched the team and with the required tools at hand removed the broken beam, replaced it with a new one, and resumed digging before the pickers caught up. Unknown to him, the writer had held the watch, and the whole delay consumed but 25 minutes. On many farms this accident would have stopped all work for at least the rest of the day and cost more than the price of the broken part and the repair tools in idle labor and delay of work.

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[1] A full account of these roses and their culture may be found in the Rural New Yorker of November 13, 20, and 27, 1909, vol. 68, pp. 981, 1002, and 1022.

These tools and extras are housed in a convenient repair shop in one end of the barn, where they are neatly and orderly arranged in cases and boxes or hung on the walls. Everything has its place, and the owner's aim is to keep it there if possible.

Some will consider many of these tools unnecessary and superfluous, and some of them doubtless are. But the retail cost of the entire outfit is only about $350, which is not a large sum. The interest on this amount at 6 per cent is only $21 a year, and it is safe to say that there has never been a year when twice this amount was not saved by them in time, labor, and cash. The average farmer has a far larger repair bill than this amount of interest and upkeep. While the average man will undoubtedly not require as many tools as this, yet here is an example which can very well be followed by many farmers to their comfort, convenience, and financial advantage.

List and cost of mechanics', machinists', and plumbing tools, etc., on the farm.

	Cost.
2 Hand cut-off saws, 26-inch	$3.00
2 Hand ripsaws, 28-inch	3.00
2 Hand keyhole saws	.50
1 Hack saw, 10-inch	.75
24 Blades, 10-inch	1.00
1 Square, 2-foot	1.50
2 Try-squares, 6 and 10 inch	.70
2 Bevel squares, 10-inch	.50
1 Tape measure, 75-foot	.75
1 Compass, 10-inch	.60
2 Calipers, 6-inch	.75
2 Marking gauges	.50
2 Claw hammers	1.00
2 Cross-peen riveting hammers	1.00
1 Blacksmith's cross-peen hammer	.50
1 Blacksmith's ball-peen hammer	.50
1 Shoeing hammer	.40
1 Rawhide mallet	1.25
1 Nail puller	$0.50
1 Broadax	1.00
2 Combination monkey and pipe wrenches, 15-inch	3.50
7 Twin alligator wrenches, 8-inch	3.50
1 Alligator wrench, 20-inch	1.00
6 Assorted wrenches	1.00
6 Assorted cold chisels	1.00
6 Assorted cold punches	.75
4 Nail sets	.25
2 Center punches	.20
2 Prick punches	.20
4 Rivet sets	.75
4 Screw drivers	1.00
1 Tool handle	1.25
1 Pair button pliers	.50
1 Pair lineman's pliers	.50
1 Pair parallel-jaw pliers	1.50
2 Pairs small pliers	.75
1 Pair round-nose pliers	.50

	Cost.
1 Pair end nippers	$1. 50
1 Pair three-fourths bolt cutters.	5. 00
1 Pair hog ringers	. 25
1 Pair gas tongs	. 40
1 Pair pulling tongs	1. 50
1 Pair cutting nippers	1. 50
2 Pairs pruning shears	1. 50
1 Parallel-jaw 6-tube punch	1. 50
1 Saw set	. 60
1 Crosscut-saw set	1. 00
1 Pair tin snips	1. 75
1 Pair bent snips	1. 75
2 Scrapers	. 25
1 Sweep brace, 16 inch	2. 50
Complete set bits, $\frac{1}{4}$-inch, 25 cents; $\frac{5}{16}$-inch, 25 cents; $\frac{3}{8}$-inch, 30 cents; $\frac{7}{16}$-inch, 30 cents; $\frac{1}{2}$-inch, 35 cents; $\frac{9}{16}$-inch, 35 cents; $\frac{5}{8}$-inch, 40 cents; $\frac{11}{16}$-inch, 40 cents; $\frac{3}{4}$-inch, 45 cents; $\frac{13}{16}$-inch, 50 cents; $\frac{7}{8}$-inch, 55 cents; $\frac{15}{16}$-inch, 60 cents; 1-inch, 65 cents; $1\frac{1}{8}$-inch, 70 cents; $1\frac{1}{4}$-inch, 80 cents; $1\frac{3}{8}$-inch, 85 cents; $1\frac{1}{2}$-inch, 90 cents	8. 60
1 Expansive auger bit, $\frac{7}{8}$ to $3\frac{1}{2}$-inch	. 65
1 Car bit, $\frac{7}{8}$-inch	. 75
1 Wood countersink	. 30
1 Reamer for iron work	. 25
1 Bit and square level	. 20
1 Taper auger	2. 00
1 Hollow auger	4. 00
1 Spoke pointer	. 50
1 Bit gauge	. 25
2 Bit extensions	. 50
1 Washer cutter	. 50
1 Hand taper reamer	. 50
Complete set brace, square-shank twist drills, $\frac{2}{32}$-inch, 7 cents; $\frac{3}{32}$-inch, 8 cents; $\frac{4}{32}$-inch, 10 cents; $\frac{5}{32}$-inch, 12 cents; $\frac{6}{32}$-inch, 15 cents; $\frac{7}{32}$-inch, 17 cents; $\frac{8}{32}$-inch, 17 cents; $\frac{9}{32}$-inch, 22 cents; $\frac{10}{32}$-inch, 24 cents; $\frac{11}{32}$-inch, 27 cents; $\frac{3}{8}$-inch, 31 cents; $\frac{13}{32}$-inch, 34 cents; $\frac{7}{16}$-inch, 38 cents; $\frac{15}{32}$-inch, 41 cents; $\frac{1}{2}$-inch, 44 cents; $\frac{9}{16}$-inch, 60 cents; $\frac{5}{8}$-inch, 68 cents; $\frac{11}{16}$-inch, 75 cents; $\frac{3}{4}$-inch, 85 cents; $\frac{13}{16}$-inch, 90 cents; $\frac{7}{8}$-inch, 98 cents; $\frac{15}{16}$-inch, $1.10; 1-inch, $1.20	10. 53

	Cost.
Post drill, upright, self-feed, and quick return	$10. 00
One-half inch straight round-shank drills, $\frac{4}{32}$-inch, $\frac{5}{32}$-inch, $\frac{6}{32}$-inch, $\frac{8}{32}$-inch, $\frac{9}{32}$-inch, $\frac{10}{32}$-inch, $\frac{12}{32}$-inch, $\frac{13}{32}$-inch, $\frac{14}{32}$-inch, $\frac{15}{32}$-inch, $\frac{16}{32}$-inch, $\frac{18}{32}$-inch, $\frac{20}{32}$-inch, $\frac{22}{32}$-inch, $\frac{24}{32}$-inch, $\frac{26}{32}$-inch, $\frac{28}{32}$-inch, $\frac{32}{32}$-inch	10. 63
Complete set reamers bit brace, $\frac{1}{4}$-inch, 25 cents; $\frac{5}{16}$-inch, 30 cents; $\frac{3}{8}$-inch, 35 cents; $\frac{7}{16}$-inch, 40 cents; $\frac{1}{2}$-inch, 45 cents; $\frac{9}{16}$-inch, 50 cents; $\frac{5}{8}$-inch, 60 cents; $\frac{3}{4}$-inch, 70 cents; $\frac{7}{8}$-inch, 80 cents; 1-inch, 90 cents; $1\frac{1}{8}$-inch, $1.10	6. 35
1 Burring reamer, $\frac{1}{2}$ to $1\frac{1}{4}$ inch	. 75
2 Iron countersinks	. 40
2 Brace screw-driver bits	. 25
Several extra bits, drills, reamers, etc	2. 00
Chisels, socket firmer, $\frac{1}{8}$-inch, 30 cents; $\frac{1}{4}$-inch, 30 cents; $\frac{3}{8}$-inch, 30 cents; $\frac{1}{2}$-inch, 35 cents; $\frac{5}{8}$-inch, 40 cents; $\frac{3}{4}$-inch, 40 cents; $\frac{7}{8}$-inch, 40 cents; 1-inch, 45 cents; $1\frac{1}{4}$-inch, 45 cents; $1\frac{1}{2}$-inch, 50 cents; $1\frac{3}{4}$-inch, 50 cents; 2-inch, 55 cents	4. 90
Gauges, $\frac{1}{4}$-inch, 30 cents; $\frac{1}{2}$-inch, 40 cents; $\frac{3}{4}$-inch, 50 cents; 1-inch, 75 cents	1. 95
Wood planes: Smoothing plane, 40 cents; jack plane, 60 cents; jointer, 75 cents; long jointer, $1	2. 75
Iron planes: Two-inch smoothing, $2; 3-inch scraper, $1.50; $1\frac{1}{2}$-inch bull-nose rabbet plane, $1; plane hollows and rounds, $10; circular plane, $2.25; router, $1.50; 1 small bull-nose plane beader, 25 cents; 1 small block plane, 25 cents; 1 leader, 50 cents	19. 25
1 Level (iron) and sights	2. 50
1 Level, wood	1. 00
1 Leather gauge knife	1. 00
1 Oilstone	. 25
1 Double carborundum stone	1. 25
1 Steel stamp, "T. E. M."	. 50
1 Set numbers (steel)	1. 00
1 Steel burning stamp, "T. E. M."	. 75

	Cost.
1 Set steel burning numbers, 0 to 10	$1.25
36 Sheets sandpaper	.25
24 Sheets emery cloth	.25
2 Pairs 6-inch iron clamps	.50
2 Pairs 10-inch iron clamps	.80
2 Pairs 12-inch wood clamps	1.00
2 Cylindrical gauges, 1/16 to 3 inch	1.00
1 Angle and circle board	50
1 Screw plate, 5/16-inch, ⅜-inch, ½-inch, ¾-inch, and 1-inch	5.00
1 Pipe screw plate, ¼-inch, ⅜-inch, ½-inch, ¾-inch, 1-inch	4.00
1 Pipe cutter, ⅛ to 1¼ inch	2.00
3 Pipe cutters	.30
6 Oil cans	.60
3 Flat files, 14-inch, 45 cents; 2, 12-inch, 30 cents	.75
1 Half-round file, 14-inch, 25 cents; 1, 10-inch, half-round, 20 cents	.45
1 Square file, 10-inch, 15 cents; 3, 14-inch, round, 45 cents	.60
2 Round files, 12-inch, 30 cents; 3, 6-inch, 25 cents; 3, 4-inch, 15 cents	.70
3 Three-cornered files, 8-inch, 25 cents; 5, slim, 8-inch, 40 cents; 3 heavy files, 6-inch, 25 cents; 2, 6-inch, 15 cents; 4, 5-inch, 20 cents	1.25
1 File brush, 20 cents; 1 steel brush, 60 cents	.80
Roundhead rivets: 5 pounds, 3/16 by ½ inch; 5 pounds, 3/16 by ⅜ inch; 2 pounds, 3/16 by ¾ inch	1.20
Tin flathead small rivets; 3 pounds assorted rivets	.40
Roundhead rivets, 12 pounds, ¼ by ½ inch, 96 cents; 5 pounds, ¼ by ⅝ inch, 40 cents	1.36
Roundhead rivets, 18 pounds, ¼ by ¾ inch, $1.44; 21 pounds, 5/16 by ¾ inch, 88 cents	2.32
Flathead rivets, 2 pounds, ¼ by 1 inch; 2 pounds, ¼ by 1¼ inch; 1 pound, ¼ by 1½ inch; 1 pound, ¼ by 1¾ inch; 1 pound, ¼ by 1⅞ inch; 1 pound, ¼ by 2⅜ inch; 2 pounds, ¼ by 3 inch	$0.90
Wood screws, 100, ½-inch, 10 cents; gross, ¾-inch, 15 cents; 100, 1-inch, 15 cents; 50, 1-inch, heavy, 10 cents; gross, 1¼-inch, 25 cents; gross, 1½-inch, 30 cents; gross, 1¾-inch, 35 cents; gross, 2-inch, 35 cents; gross, 2¼-inch, 40 cents	2.15
Roundhead nickel screws, 60, 1⅛-inch, 15 cents; 200 assorted spring keys, 75 cents	.90
Harness extras, buckles, snaps, rings, clips, staples, etc	2.00
1 Blacksmith's vise, 6-inch jaw	10.00
1 Woodworker's vise, 5-inch jaw	5.00
1 Foot-power lathe, No. 10, 3-cone, back gear, 14 by 30 swing, longitudinal and cross feed	40.00
1 Four-jaw, 6-inch chuck, universal or independent chuck	10.00
6 Adjustable lathe cutters, 2 straight, 1 right, 1 left, 1 straight cutting off and 1 offset, and 1 inside-boring tool	12.00
1 Arbor, ¾-inch	1.50
9 Taper-shank twist drills, 21/32, 22/32, 23/32, 24/32, 25/32, 26/32, 27/32, 28/32, 29/32	5.00
1 Screw-pitch gauge, 7 to 36	1.00
1 Center gauge	.40
5 Pounds small nails, 40 cents; spring wire, 25 cents	.65
1 Grindstone	5.00
1 Swing horse	4.00
1 Forge, anvil, and tools, etc	35.00
1 Barrel castor machine oil, No. 1	10.00
	[1] 228.64

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[1] A few tools are not mentioned.

SUMMARY.

(1) This bulletin is the story of the struggles and successes of a plain New York farmer who remained on the farm through the "hard-times" period, and succeeded.

(2) The farm was an average one for the section and the owner had all the drawbacks of an ordinary farmer, such as indebtedness, lack of capital, run-down land, poor drainage, etc.

(3) The organization of this farm is the most striking thing about it, making it one of the best organized farms in the United States. A well-developed systematic plan was followed from the first and carried to success.

(4) This farm is thoroughly tile drained with more than 10 miles of tile, or 56 rods per acre, according to a systematic plan followed since 1897.

(5) The rotation is the simple one of wheat, clover, and potatoes. This is an excellent rotation, because it has two good cash crops and one fertility crop every three years.

(6) Wheat has averaged 25.6 bushels per acre for the past 12 years. The last six years show an increase of 5.2 bushels per acre over the previous six years.

(7) Clover is the key to the success of this rotation. From uncertain and poor stands it has become a certainty and averages 2 to 4 tons per acre for the first cutting. The second crop is usually plowed under.

(8) Potatoes are the money crop. The average yield per acre for the last nine years has been 282 bushels, as against 132 bushels for the preceding nine years, an increase of 150 bushels per acre, due to better drainage, seed selection, and better cultivation, fertilizing, and spraying methods.

(9) Successful farming should be measured not only by financial results but by the resultant productive condition of the soil, the farm home, and the farm equipment and conveniences.

(10) Measured by net income this farm may be called fairly successful. During the last nine years it has paid the owner an average net return of over $700 per year, or 7.1 per cent on an investment of $10,000, and an annual salary of $300.

(11) A good farm home, an exceptionally fine garden, grounds, and home orchard, and a model small-tool equipment are also marks of success.

(12) Perhaps the most striking thing about this farm outside of its organization is the remarkable increase shown in the second 9-year period over the preceding 9-year period, due to the methods employed.

(13) This farm is a conspicuous example of model farming that pays. The secret of success is a well-developed systematic plan of organization well followed.

O

Issued August 14, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 455.

RED CLOVER.

BY

J. M WESTGATE,
Agronomist in Charge of Clover Investigations, Bureau of Plant Industry,
AND
F. H. HILLMAN,
Assistant Botanist, Bureau of Plant Industry.

With Notes on the Insect Enemies of Red Clover, by F. M. Webster,
in charge of Cereal and Forage Insect Investigations,
Bureau of Entomology.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 10, 1911.

Sir: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript on Red Clover, prepared by Mr. J. M. Westgate, Agronomist in Charge of Clover Investigations, and Mr. F. H Hillman, Assistant Botanist, Bureau of Plant Industry, with notes on insect enemies of red clover by Mr. F. M. Webster, in charge of Cereal and Forage Insect Investigations, Bureau of Entomology.

The increasing difficulty of obtaining successful stands of clover, where in former years it grew readily, constitutes one of the most serious agricultural problems of the present generation. The different viewpoints of the authors have been combined and it is thought that the data and conclusions presented will enable farmers in the clover-producing States to continue the growth of this crop with more certainty of success than is at present the case in many sections.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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RED CLOVER.

INTRODUCTION.

Red clover may justly be styled the corner stone of agriculture in the North Central and Eastern States. Either alone or in mixtures with grasses for hay or pasture it generally constitutes from one-eighth to one-third of the total area of cultivated land on most successful farms throughout this area, and is an important crop far beyond these boundaries. For centuries it has constituted one of the important factors in maintaining a permanent system of agriculture in the Old World. In this country for a century and a half it has assumed a more and more important rôle in conserving the natural resources of the soil, thereby tending to maintain the profitable yields of the staple agricultural products.

Red clover is utilized both as a hay and as a pasture crop and often as a soiling crop. It is sometimes used as a green-manure crop to be plowed under if the ground is poor in humus. Even where it is cut for hay and only the roots and stubble turned under it has a marked influence in increasing the yields of succeeding crops. It makes an ideal hay for cattle and in the clover sections should constitute from one-half to two-thirds of the roughage ration of milk cows. Sheep and young stock of all kinds make excellent gains on either the pasture or the hay. In addition to its usefulness as a food for animals it has a most important effect upon the land in maintaining the supply of nitrogen in the soil. By means of the nitrogen-fixing organism on its roots the red clover plant is able to gather large quantities of nitrogen from the air and leave it in the soil in a form which can readily be utilized by growing crops. It not infrequently happens that the yield of a grain crop can be doubled by the growing and plowing under of a crop of clover.

The most serious problem at present confronting the American farmer in many of the clover sections is the increasing difficulty of successfully maintaining stands of clover upon the farm.

With continuous cropping and the consequent depletion of the soil of humus and plant food the difficulty of growing red clover is greatly increased. This condition must be met and solved, since the loss of clover or its equivalent from the rotation leads rapidly to a run-down farm and unprofitable crop yields.

It should be emphasized, however, that the mere introduction of red clover into the farm rotation is not in itself a sufficient procedure to maintain indefinitely the productivity of the farm. The clover plant adds only the nitrates to the soil and removes large quantities of potash, phosphorus, and lime from the soil, especially when cut for hay and the manure resulting therefrom is not returned to the land. The increased supply of nitrogen may in fact stimulate the soil to increased yields temporarily, only to leave it after a few years in a condition worse than if no clover had been grown. The details of the proper handling of fields in this connection will be given in the succeeding pages. The first part of the discussion will treat of red clover without reference to the grass mixtures which are often seeded with it.

HISTORY AND PRESENT DISTRIBUTION OF RED CLOVER.

Red clover is native to the greater part of Europe and portions of Asia. Most writers hold that it was not cultivated by the ancients, although Virgil, writing in Italy about 2,000 years ago, advocated the use of cloverlike plants for improving soil and as a valuable feed for milk cows. It is probable, however, that the plants to which he referred did not include the red clover. It is known to have been grown in Spain and Italy as early as the fifteenth and sixteenth centuries, but did not reach England apparently until 1633, being introduced from Flanders (Netherlands). The exact date of its introduction into this country is not known, but in a work on agricultural plants, written in 1747 by Jared Eliot, observations concerning its adaptability to conditions in the New England States are noted. Since its introduction into this country, it has spread extensively and is now grown to a considerable extent in practically all the sections of the United States where there is sufficient rainfall. In the irrigated sections of the arid portions of the West, alfalfa is usually produced instead of red clover, on account of its long life and the greater number of cuttings possible per season; but even in the irrigated sections in mountain valleys red clover is an important forage crop.

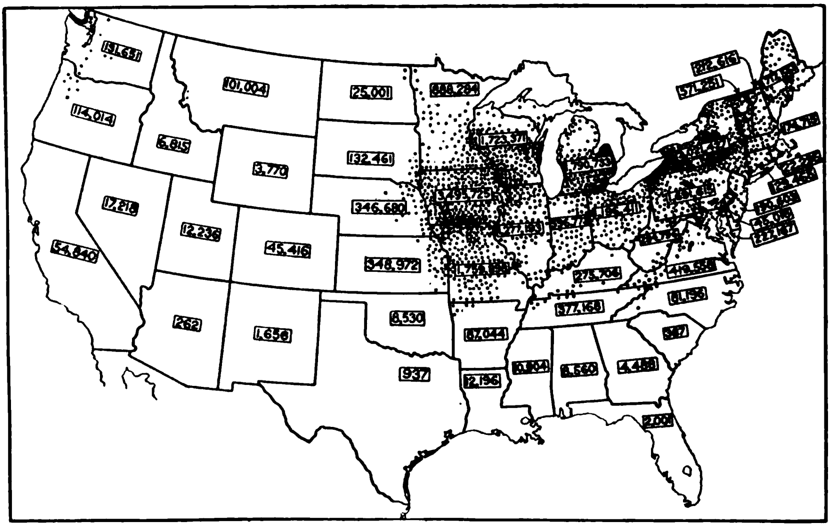

FIG. 1.—Map of the United States, showing the distribution in 1910 of clover and mixed clover and timothy.

The accompanying map (fig. 1) shows the distribution of all clovers and of mixed clover and timothy in the United States according to the census of 1910. Each dot indicates 10,000 acres in the region where the dot is located. Counties having less than 5,000 acres are not dotted.

DESCRIPTION OF THE RED CLOVER PLANT.

The accompanying illustrations (figs. 2 and 3) indicate the general appearance of the red clover plant. The plant is entirely herbaceous and is composed of numerous leafy stems arising from a crown. It usually lives only two years and for this reason is especially adapted to short rotations. The flowers are borne in compact clusters or heads at the tips of the branches. There may be a hundred or more flowers to a single head. The flowers are rose-pink, somewhat similar in shape to pea flowers but much more elongated and smaller, being one-half inch in length and one-sixteenth inch in width. The pods bear little resemblance to the pods of most other legume-bearing plants; they are small, short, and break open transversely instead of longitudinally as do pea and bean pods. (See fig. 4.) The kidney-shaped seeds are one-twelfth of an inch long and vary in color from yellow to purple. The stems comprise about three-fifths of the total weight of the plant above ground and are usually somewhat hairy. Each leaf is divided into three oblong leaflets, usually with a pale spot in the center of each. The roots are much branched but usually deep feeding and are ordinarily well supplied with the nitrogen-gathering tubercles (fig. 3).

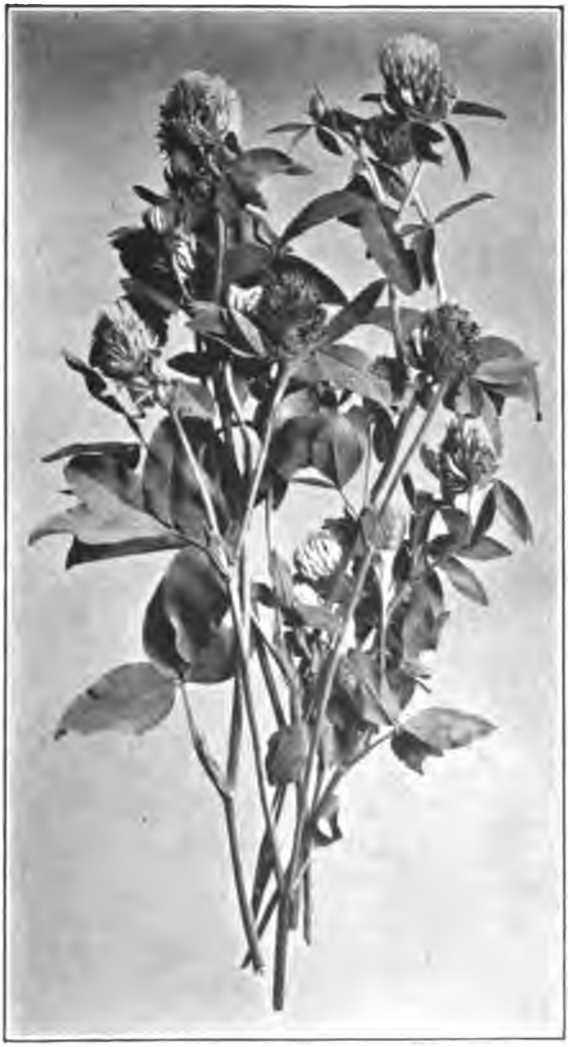

FIG. 2.—Stems of red clover in different stages of bloom.

ADAPTABILITY OF RED CLOVER TO VARIOUS SOILS AND CLIMATES.

Red clover is the staple leguminous forage crop in the North Central and Northeastern States. Although the distribution map (fig. 1) shows clover to be grown principally in the States bordering the Great Lakes, a great deal of clover is also raised in North Dakota, South Dakota, Montana, Oregon, Washington, and the Southwestern States. It does not give its best returns in the extreme South nor is it always quite able to withstand the more severe winters in North Dakota and Minnesota.

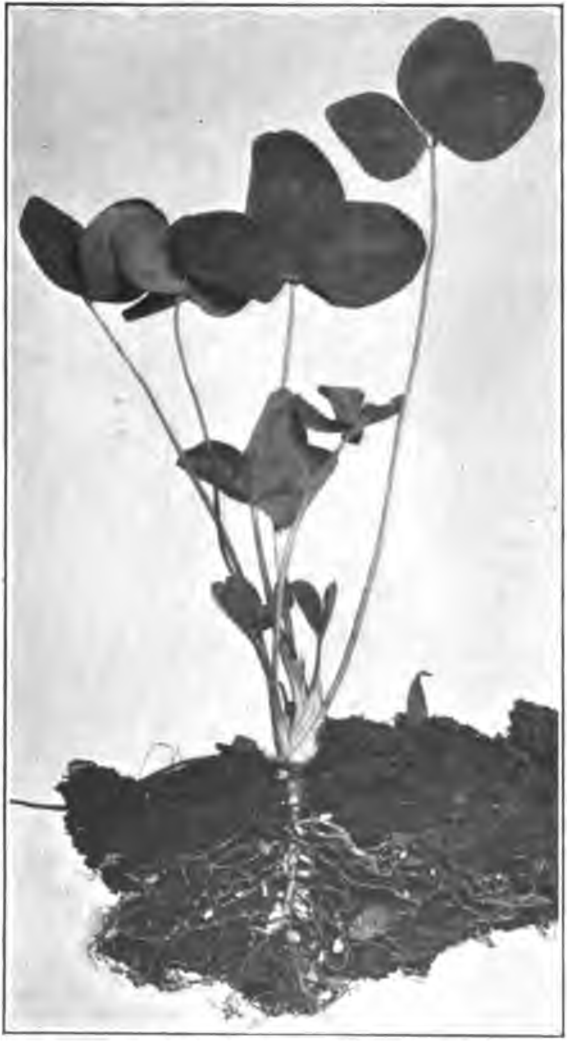

FIG. 3.—Young red clover plant, showing tubercles on roots.

In irrigated sections clover can be grown, but usually it can not compete with alfalfa, which makes more cuttings in a season and lasts much longer from one seeding than the red clover plant. In some irrigated sections red clover is preferred, as in high mountain valleys where the growing season is too short for three crops of alfalfa and especially where a leguminous hay crop is desirable in connection with the customary grain crop. It makes its best growth on rich, fertile, well-drained soil containing an abundant quantity of lime and reasonably free from weeds; but it is not so exacting as alfalfa in these respects. To low, poorly drained soils it is not so well adapted as alsike clover. Alsike will also succeed on the so-called clover-sick lands upon which for one reason or another red clover can no longer be successfully grown.

REQUIREMENTS FOR OBTAINING A STAND OF RED CLOVER.

CHOICE OF SEED.

It is important that considerable care be taken in choosing the seed to be sown. If poor seed be used the expected crop may be a partial or total failure. In addition the loss of the labor involved in putting in the crop may be a considerable item of expense. It is essential to know the characteristics of both good and poor seed in order that an intelligent selection may be made.

Characteristics of good seed.—Good red clover seed is plump or well filled, bright with a slight luster, the color of individual seeds ranging from violet to light yellow. The individual seeds should be at least of medium size and fairly uniform. The seed should be free from adulterants of any kind and also free from seeds of noxious weeds. Very new seed is often undesirable to sow because of the hard seed it contains.

Hard seed.—The so-called hard seed has a coat in such a condition that it absorbs moisture very slowly and may not germinate for a period of several weeks or even months. In very new seed the proportion of hard seed may amount to as much as 50 or 60 per cent. A year or two later a much greater proportion of the same seed will germinate promptly. A germination test readily shows the proportion of hard seed present in any given sample.

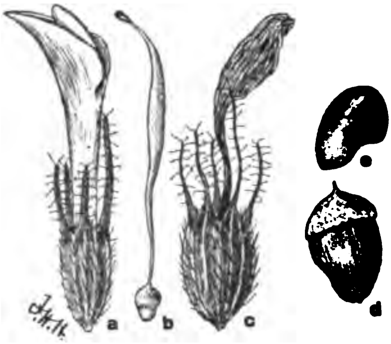

Fig. 4.—Stages in the development of red clover seed: *a* and *c*, Flower in prime and ripe; *b* and *d*, immature and mature seed vessel; *e*, mature seed.

Advantages of home-grown seed.—Several advantages attend the use of home-grown seed. In the first place it is quite certain to produce a crop especially adapted to the local climatic conditions, more so than seed brought in from a distance and usually from an unknown source. Home-grown seed is not likely to contain impurities foreign to the neighborhood and it is usually possible to obtain seed from fields known to be free from dodder, buckhorn, dock, etc. The age of home-grown seed may usually be definitely determined. This is usually impossible with seed purchased in the open market. Open-market seed may be excellent or it may be very undesirable. If seed is to be purchased from other localities care should be taken that it comes from a region possessing at least as rigorous a climate, especially if there is any necessity of seeding a hardy strain of clover.

Characteristics of poor seed.—Red clover seed may be poor and undesirable from several points of view. Such seed is constantly being sold to farmers and should be recognized and rejected. It may be poorly developed, many seeds being shriveled and dull brown in color. Such seeds will not produce plants. Often red clover is adulterated by the use of yellow trefoil, dead clover seed, cheap imported seed, or weedy screenings. Each of these constituents reduces the stand of healthy plants and makes the purchaser pay for what he does not get, transportation included. He is also likely to get an undesired crop of weeds, some of which may become a decided menace to his locality.

Cleaning red clover seed.—Some of the weed seeds appearing in red clover seed can be removed by the farmer by the use of a wire-cloth sieve containing 20 meshes to the linear inch. Most of the clover seeds of medium size are held back by such a sieve and practically all the smaller weed seeds pass through. The true clover dodder which is a very noxious pest in clover fields is quite effectively removed in this way. Most of the seeds of the field dodder are also removed.[1] Seed of buckhorn, wild carrot, wild chicory, thistles, and others of similar size (fig. 5) are mostly held back by the sieve. The small-grained clover seed imported from Europe largely passes through such a sieve. A method of separating buckhorn seed from clover has been devised and published by the United States Department of Agriculture.[2] In brief this method consists of mixing with the seed containing the buckhorn thoroughly wetted sawdust. The buckhorn seed becomes sticky on being wet and readily attaches itself to the sawdust. The entire mass is then immediately screened when the larger particles of sawdust with the buckhorn attached are readily separated from the clover seed. This work should be done immediately before sowing the clover seed which with the small particles of sawdust that pass the screen need to be dried only sufficiently to enable the seeding to take place readily. This is an effective means of removing practically all viable buckhorn seeds and is easily accomplished by the farmer who handles a comparatively small quantity of seed which is not necessarily bulked immediately after the somewhat damp seed has been screened out.

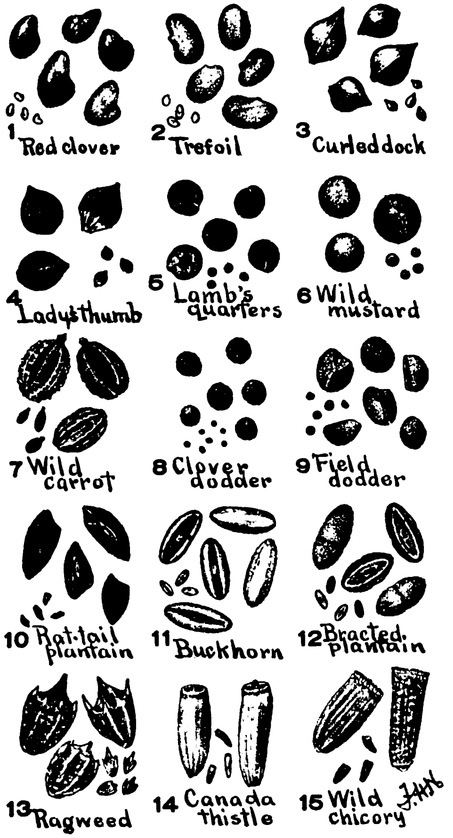

FIG. 5.—Seeds of red clover and common impurities.

The purchase of red clover seed.—The quality of the seed as previously discussed should receive more attention than has usually been given it. If home-grown seed produced under known conditions is not available, samples should be procured from reliable dealers.

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[1] See Farmers' Bulletin 306, entitled "Dodder in Relation to Farm Seeds." by F. H. Hillman.

[2] Shaw, H. B. An Improved Method of Separating Buckhorn from Red Clover and Alfalfa Seeds. Circular 2, Bureau of Plant Industry.

These should be examined for adulterants, weed seeds, and shriveled seeds. They should also be tested for germination before purchasing. Cheap, poor seed is often mixed with good seed and sold at the price of good seed.

Making the seed test.[1]—In the absence of more accurate methods an estimate should be made of the proportion of true red clover seed and of weed seeds and other impurities. From the red clover seed separated from all impurities a counted number, as 100, should be taken just as they come. These seeds should be placed between layers of moistened cloth or paper or merely covered in a bed of sand or light soil. The germinating receptacle (fig. 6) should be held at a temperature of a living room, varying between 65° and 85° F. Between the third and sixth days the sprouting ability of the seeds should be shown. Seeds which at the close of a week are still hard, not yielding to the pressure of a knife blade, are "hard" seeds and are to be considered little better than dead seeds for sowing. It should be borne in mind that the sowing value of the seed is represented by the amount of true clover which will germinate with reasonable promptness. Thus, if four-fifths of a sample is pure clover and but three-fourths of this clover will sprout, then only three-fifths or 60 per cent of the original seed as offered will grow. The examination of the seed is facilitated by the use of a magnifier; the kind shown in figure 7 is easily obtainable for about 50 cents. Some of the more important weed seeds are shown in figure 5.

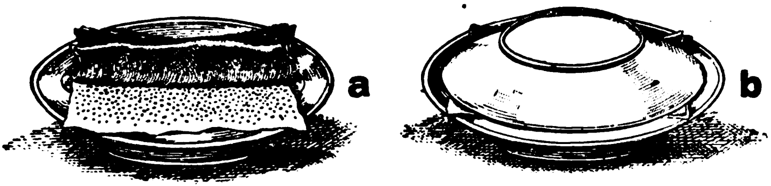

FIG. 6.—Homemade seed tester or germinator.

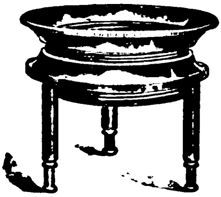

FIG. 7.—Simple magnifier for examining seeds.

SOILS ADAPTED TO RED CLOVER.

As a general rule throughout the clover belt any soil that will grow corn successfully will produce satisfactory crops of red clover. A deep soil is desirable for red clover in order that it may utilize fully its extensive root system, which may extend down as far as 5 or 6 feet. Red clover is a legume that will grow in soil relatively low in nitrogen so long as there is a sufficient supply of this element to start the plants, until they have opportunity to develop tubercles on the roots. Absence of sufficient humus, however, makes it very difficult if not impossible to secure a profitable stand of clover. Red clover will not succeed if the ground is poorly drained or if the land is in any way boggy. On such soils it is better to seed alsike instead of red clover. One effect of poor surface drainage, especially on uplands, is to induce heaving during the winter and early spring. The surface drainage of the field may often be facilitated by backfurrowing, leaving the dead furrows at intervals of 1 rod or less. These furrows furnish means for the storm waters to run off quickly in the event of heavy rains. The limestone areas of the country are usually very well adapted to the production of red clover. Where the soil is decidedly deficient in lime, as in many eastern States and in some portions of eastern Ohio, southern Indiana, and Illinois, this mineral must usually be supplied artificially.

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[1] For detailed directions for making seed tests, see Farmers' Bulletin 428, entitled "Testing Farm Seeds in the Home and in the Rural School," by F. H. Hillman.

PREPARATION OF THE SEED BED.

Clover is usually seeded in the spring on winter grain. In such cases no special preparation of the seed bed is necessary, as the frost has usually cracked the ground sufficiently to render natural covering a reasonable certainty. If seeded with a spring-sown nurse crop the preparation accorded the land for the grain crop is usually sufficiently thorough for successful results with red clover; but it is necessary to have the seed bed fine and reasonably firm if prompt germination and proper establishment of the young plants is to be accomplished.

When clover is seeded alone—a very desirable practice on poor, run-down farms—a firm, fine, well-settled seed bed is highly desirable. For this reason the clover should not be seeded on freshly plowed land which has been given no opportunity to settle. Several workings with soil packers or harrows are usually necessary unless a heavy rain intervenes to settle the ground to the proper condition. If the ground has been previously planted to an intertilled crop, such as corn, plowing is not always necessary, as a good disking will generally put the ground in proper condition for red clover. It should be remembered that red clover, especially in its early stages of development, is not drought resistant; in seasons of drought, or on land which drought affects badly, special care should be taken looking to the conservation of the moisture in the soil.

FERTILIZERS FOR RED CLOVER.

Under ordinary conditions the red clover crop is able to succeed by utilizing whatever fertilizer has been used in connection with the crops immediately preceding or with which the clover is sown; but on soils which are somewhat low in fertility profitable returns are made more certain by top-dressing with manure previous to the time of seeding. (Fig. 8.) The soil may lack a sufficient quantity of one or more of the principal fertilizer elements essential to the production of red clover. This deficiency may be supplied in the form of commercial fertilizer if manure is not available in sufficient quantities. Clover soils in the clover belt generally appear to be somewhat deficient in phosphorus but usually have enough potash and nitrogen.

When barnyard manure is used as a top-dressing, from 6 to 10 tons per acre should be scattered, preferably with a manure spreader, as this insures a fine and even distribution. The manure may often be applied advantageously to the preceding crop, especially if it be a crop like corn, the cultivation of which kills the weeds. A sufficient residue will usually be left to produce a satisfactory growth of the young clover plants. Wood ashes when available may also be applied.

The use of such soil amendments as lime and gypsum very often gives large returns for the comparatively small outlay for their application. Such materials usually act not so much in supplying food to the plant as they do in neutralizing any acidity which may be in the soil or in liberating other plant foods, thus enabling the clover plants to make a better growth. During recent years the use of lime and potash has largely supplanted the use of gypsum for clover except in Oregon and Washington. (Fig. 9.) When lime is used 600 to 2,000 pounds per acre of quicklime applied as a top-dressing and thoroughly worked into the soil may be used, or 1 to 2 tons of ground, unburned limestone. If available the latter form is recommended unless carriage charges make it considerably more expensive. When gypsum is applied it is scattered at the rate of 40 to 200 pounds per acre. On poor, sandy soils an application of 200 pounds of bone meal or 250 pounds of acid phosphate (containing 12 to 14 per cent of available phosphoric acid) and 50 to 100 pounds of muriate of potash usually makes a very satisfactory top-dressing for all kinds of clover. On most clay-loam soils the bone meal or acid phosphate alone is ordinarily sufficient without the potash.

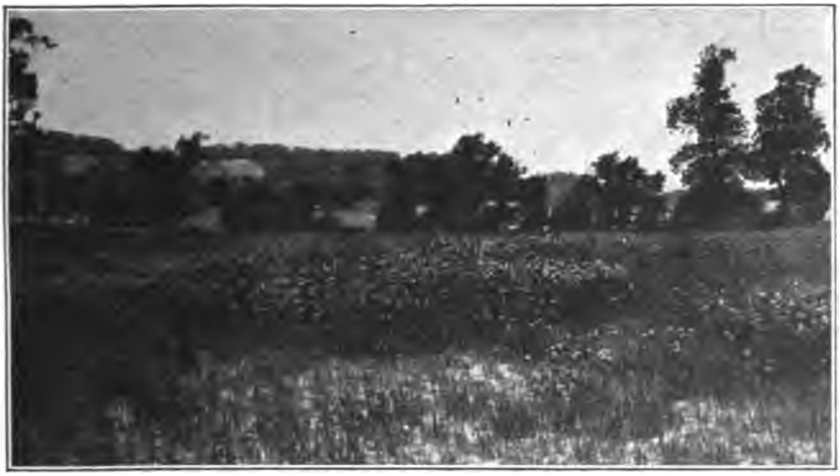

FIG. 8.—Red clover field, showing the effect of top-dressing with manure. The area in the immediate foreground received no manure; the area immediately behind received a light application, resulting in a very vigorous stand of clover.

SEEDING RED CLOVER.

Red clover often fails to catch because it is not planted sufficiently deep to insure proper moisture conditions for the young seedlings. In light or sandy soils the seed should be covered 1½ to 2 inches deep, while in clay soils the covering should be about 1 inch. For prompt germination it is advisable on reasonably loose lands, especially sandy lands, to roll the ground after seeding. If a smooth roller is used, it should be followed by a light harrow to roughen the surface and thus prevent rapid evaporation of the soil moisture. Shallow seeding is especially disastrous in case of insufficient rainfall. Red clover may be seeded about six weeks before frost in the autumn or in the early spring while the ground is still freezing and thawing daily. It may also be seeded in the late spring after the ground has become warm. The late summer or early fall seeding is recommended in seasons where there is ample moisture or where spring seedings for any particular reason do not succeed.

It is a practice with many to seed clover as early as February, while others may wait until April with apparently equal success. Still others sow half the seed early and half late since a very light seeding will suffice if the conditions are exactly right. It may be seeded on a late snow with good chances of success. One advantage of early spring seeding is that it may be done when other farm work is not pressing and very little labor is necessary in connection with the seeding operation. In the event of failure, the farmer loses but very little besides the seed used. If the soil is plentifully supplied with humus and if moisture and other conditions are favorable, a fairly good catch of clover may be expected, but at best there is considerable uncertainty, and in the older and more run-down soils this uncertainty is becoming greater and greater each year. A failure of the seed to catch is a serious matter, as the elimination of clover from the rotation is rapidly followed by decreased yields of the standard grain crops. It must be admitted that the mere seeding of

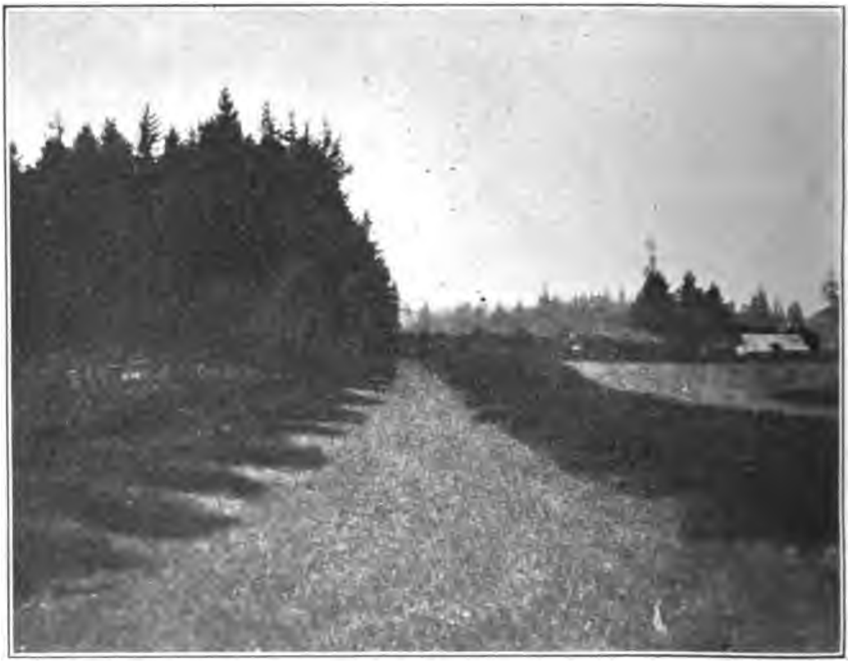

FIG. 9.—View showing the marked effect of land plaster on the growth of red clover. The dark streaks at the right and at the left show the heavy growth where plaster was applied; the light streak in the center shows the scanty growth where no plaster was applied.

the red clover on wheat without any other attention is not giving the red clover the best possible chance of success.

Other methods of obtaining a catch of red clover, much more certain than the usual one just outlined, call for an increased amount of labor in preparing the seed bed, and under some conditions for the entire use of the land for the better part of the season. The early spring seedings are the rule where red clover grows readily. Under such conditions it is seeded in winter grain upon the land when in "honeycombed" or tessellated condition; that is, filled with small frost cracks, in which the seeds find lodgment (fig. 10). In many localities where difficulty is experienced in obtaining satisfactory stands of clover by seeding in the usual way on wheat in the early spring, it has been found advisable to harrow the wheat when the clover is seeded. The more certain method appears to be to harrow the wheat immediately in advance of the seeding and then reharrow to cover the clover seed. This insures a deep covering of the clover and a better establishment of the plants. This harrowing will prove especially advantageous in the event of any lack of rainfall which may occur during the season. The harrowing does not appear to injure the wheat. If timothy has been seeded in the wheat the fall before, some of the young seedlings will be destroyed, but enough will survive the two harrowings to give a satisfactory stand. Being of greater importance than the timothy, the clover should have first consideration. When the clover is to be put in with a harrow, it is important to wait until the field is in a good condition to harrow. The seeding should be done at the earliest possible moment that the soil conditions are right, but this may call for a delay in seeding until as late as the first of May. It is not well to put off the seeding until the wheat gets so high as to interfere with the harrowing operations.

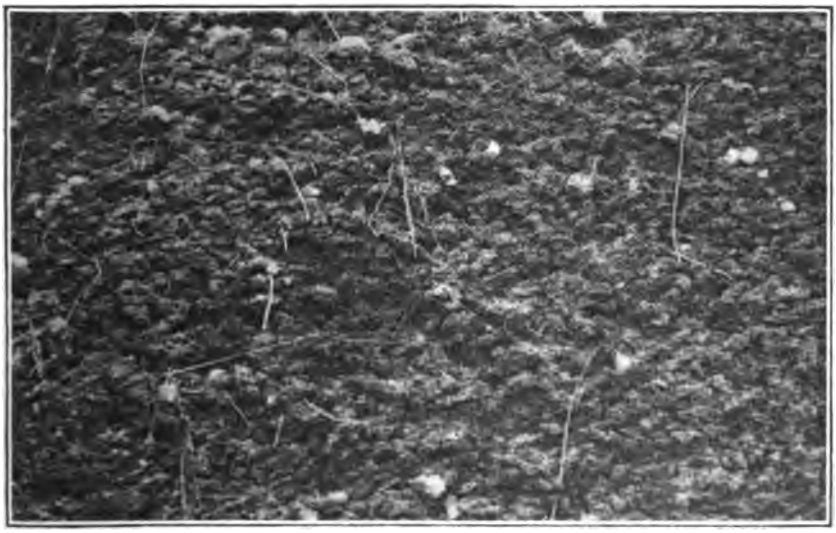

FIG. 10.—Close view of soil honeycombed by frost and in proper condition for seeding clover. The numerous irregularities become leveled when the ground thaws, resulting in a natural covering of the clover seed by the soil.

The harrow should be set to cover the seed to a depth of about 1 inch. The greatest objection to this method is that the work must be done when the preparation of the ground for other crops is under way. Owing to the fact that the clover is of such great value as a soil improver, together with its importance as hay, this means of obtaining a good stand of clover can not be urged too strongly in sections where the usual method of seeding fails. If an early seeding on snow or frozen ground fails, a later seeding can be made and harrowed in. A successful stand of clover is important, even at the expense of one or two reseedings. If not seeded on winter grains by one or the other of the methods already noted, it is usually sown with a spring-seeded grain crop, both the clover seed and grain being put in at the same time. However, the grain is usually planted at a somewhat greater depth than the clover.

Red clover may be seeded either broadcast or with one of the various makes of seeders or with a regular grain drill with a seeder attachment. Some care and experience are necessary in seeding broadcast by hand in order to get an even stand with the small quantity of seed usually used. An advantage which the clover seeders offer is that no special experience is necessary in evenly seeding the desired quantity per acre. One successful type of seeder consists of a seeding attachment in front of a 1-horse weeder, which covers the seed to the proper depth in reasonably firm soils. When seeded with grain, better results are usually obtained by cross seeding the clover, as in this way the ground not utilized by the grain is available to the clover plants. Otherwise the two have to struggle for supremacy in the same row, often to the injury of each. In northern Indiana and a few other places it is coming to be a more or less common practice to use a disk drill in sowing red clover in wheat, but some use a shoe drill. In using a drill for this purpose the seeding attachment should be placed in front of or just back of the drill. With shoe drills the clover seed is allowed to drop through the grain tubes. This is a very effective method of getting a good stand of clover. The wheat rows should run north and south in order to give the clover the greatest quantity of sunlight. In seeding clover, 8 to 10 pounds are usually sufficient. This weight of seed is often mixed with 10 to 12 pounds of timothy.

USE OF NURSE CROPS WITH RED CLOVER.

Where no difficulty is experienced in growing red clover, it is the customary practice to seed with some nurse crop. In sections growing winter wheat it is usually seeded on the wheat in early spring, when the alternate freezing and thawing of the honeycombed ground covers the seeds sufficiently to render a good stand reasonably certain. In sections where the seeding of spring-sown grain is the rule it is the general practice to seed the clover either with or immediately after the grain. In light sandy soils the two may be drilled into the grain furrows, as under such conditions the deep covering of red clover is an advantage. On other soils it is necessary to cover the clover to a less depth than the grain, and this may be brought about by seeding the clover in front of the drill shoes or by seeding it after the drill and harrowing it in. When seeded in the spring on fall-sown grain, wheat is the usual nurse crop, but rye is more favorable to the growth of clover, because it produces less shade than wheat. If the rye is used in spring for pasturing, the trampling incident to the pasturing will assist in covering the clover seed.

Of the various nurse crops, oats are perhaps most unfavorable to the growth of the clover on account of the dense shade produced; but the value of the oat crop itself makes it often to be preferred to such crops as barley, which is less injurious to the clover because it makes less shade. The advantages of a nurse crop are (1) that a grain crop is produced, avoiding the loss of the use of the land for one season, and (2) that the stubble of the grain serves as a winter protection to assist in catching and holding the snow which otherwise might drift from the field and render the clover plants more liable to be winterkilled. In sections where there is frequently a lack of timely rains a nurse crop greatly decreases the chances for a successful stand of clover.

Another method distinct from that of seeding in the spring with spring-sown grain or on a stand of fall-seeded grain is that of seeding in corn at the last cultivation, and this method is coming more and more into use. (Fig. 11.) This method gives fair results unless there is lack of rainfall during the late summer and early fall; but it does not appear to give satisfactory results on clay uplands. North of central Ohio and Indiana this method may result in the winterkilling of such of the young plants as are unable to make more than a 6-inch growth before cold weather. If moisture conditions are favorable there is usually sufficient sunlight for the development of the young

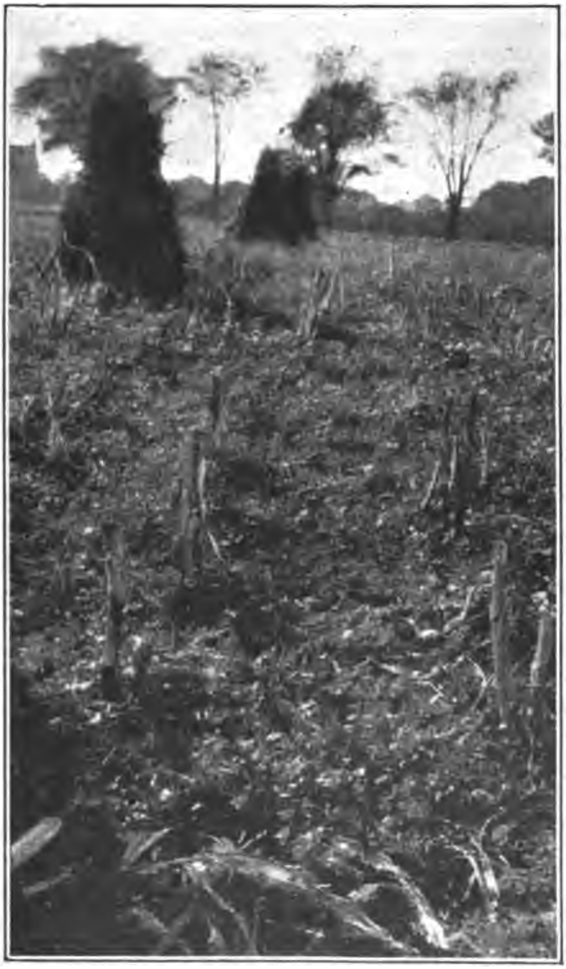

FIG. 11.—A cornfield in which clover was seeded at the last working of the corn.

clover plants, and a good crop of hay is possible the next season without the loss of the use of the land for a season. This method is commonly practiced throughout the New England States and has been recommended in sections where clover does not do well when seeded in the spring with a nurse crop.

Successful stands have also been produced by seeding with rape in late summer. When the rape is fairly well grown it is grazed down without much injury to the clover. Seeding with turnips after early potatoes is sometimes practiced in the eastern States. Some farmers practice the method of plowing down some red clover that has matured seed when turning under the sod. When the land is replowed this seed usually germinates sufficiently well to produce a fairly satisfactory stand. For this purpose late fall or early spring plowing is best.

SEEDING WITHOUT A NURSE CROP.

Where none of the methods already discussed prove successful it is necessary to seed the clover alone and give the crop the entire use of the ground. By seeding clover in the spring without a nurse crop, a good crop of hay may be obtained the first season, the stand is more certain, and the plants are not injured by the lodging or shading of the grain. If weeds prove troublesome, they may be clipped back with the mower. Should there be any tendency to drought during the summer, the water supply available for the clover plants is much greater when seeded alone than when seeded with a nurse crop. The land should be thoroughly prepared and well settled and the seed sown and covered to depths ranging from one-half inch in heavy soils to 2 inches in very light sandy soils. In the northern States seeding alone any time from early spring until the middle of August may be successfully practiced. Except in the extreme north, seeding as late as August 15 allows the plants time to make a fair growth before winter, and good yields of hay can be expected the following season. By following such a crop as early potatoes or grain, this method entails no loss of the use of the land. The extra labor incident to the preparation of the land for the crop is the principal drawback to this method, which is usually much more certain in its results than seeding with a nurse crop.

INOCULATION OF RED CLOVER.

In order to make its best growth, the red clover plant must be supplied with nitrogen-gathering bacteria on its roots. The tubercles containing these bacteria are shown in figure 3. Fortunately, this crop has been grown so long in this country that most soils appear to be fairly well supplied with these germs, and usually no artificial application of them is necessary. When the clover is being tried as a new crop in a section it often does not become well inoculated until it has been grown for two or three seasons on the same piece of land, after which natural inoculation takes place and good crops are grown without further difficulty. By scattering the clover straw and chaff (remaining after hulling the seed) on the land to be seeded to clover, it has been observed that beneficial results follow, more in fact than would naturally be expected merely from the manurial effect of the clover stems so applied. It is probable that a portion of the observed increase in the vigor of the clover plants is due to the bacteria which may be applied with the leaves and chaff. When seeding clover upon land for the first time, it is well to provide for artificial inoculation, but after clover is established on a farm this procedure is usually unnecessary. This artificial inoculation may be accomplished either by scattering soil from some old, healthy, weed-free clover field or by the use of pure cultures.[1]

The soil-transfer method of inoculation.—Inoculation by the soil-transfer method is generally more certain in its results than the pure-culture method, but where the soil is brought in from some outside locality not known to be free from noxious weeds, insect enemies, and plant diseases, there is danger of introducing such pests.

The soil-transfer method consists in scattering over the new ground, at the rate of 200 to 300 pounds to the acre, soil from a healthy clover field where the plants show an abundance of the tubercles on their roots. It is suggested that the seed be mixed with a small portion of this soil and the remainder drilled or scattered broadcast and immediately harrowed in. This should be done preferably on a cloudy day or toward evening, as the sun's rays are very injurious to the germs; but if the person who scatters the soil walks directly in front of the harrow the sun has practically no opportunity to harm the germs. To facilitate even scattering, the soil may be mixed with two or three times its own weight with ordinary soil obtained close at hand to save carriage charges.

The pure-culture method of inoculation.—The results with pure cultures are less certain than where the soil-transfer method is employed, but the pure-culture method has the advantages of greater ease of transportation and freedom from danger of introducing harmful pests upon the farm. The method of inoculation by pure cultures may be carried out in either of two ways: (1) A bottle of pure culture of the proper kind of bacteria is opened and the culture mixed with a convenient quantity of water; this diluted culture is now thoroughly mixed with a considerable quantity of soil, preferably from the field where the legume is to be sown; the treated soil is then distributed in the same manner as when inoculation is made by the use of soil from an old field. (2) A pure culture of the proper kind of bacteria is prepared according to the directions accompanying the bottle, and is then applied to the seed in such a way that all of the seed may be moistened, though not soaked. The seed should be planted as soon as practicable after this treatment—that is, as soon as it is sufficiently dry for convenient handling. Drying may be facilitated by adding dry, sifted earth, preferably from the field in which the leguminous crop is to be grown. The nodule bacteria very often die within a week after the seed is inoculated and dried; it is therefore highly desirable that the inoculation be made the same day the seed is sown. Inoculated seed should never be dried in the sun, as direct sunlight is quickly fatal to the bacteria.

TREATMENT THE FIRST SEASON.

When seeded with a grain nurse crop no special treatment is given the clover the first season. It develops in the stubble after the grain has been cut and occasionally may afford some pasture the same fall. If the late summer be especially favorable sufficient growth may be made for a cutting of hay, and in some cases a crop of seed has been secured. The stand, however, is apt to be injured by the cutting, and it is usually best to clip back the growth to check the development of the plants. When seeded in the fall in corn or with rape one or two crops may be expected the next season in addition to considerable pasture. A top-dressing of barnyard manure acts very favorably on red clover at any time. A light top-dressing of gypsum may also be of advantage if the clover appears to lack vigor. This can be applied on the young plants when about 6 inches high, and even in early spring the following year (fig. 9). It is not advisable to pasture spring seedings the same season with sheep or hogs, as they are likely to injure the young plants. Pasturing with cattle is less injurious.

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[1] See Circular 63, Bureau of Plant Industry.

TREATMENT THE SECOND SEASON.

Common red clover usually lives but two years. The second season the first crop is usually cut for hay and the second crop for seed. The aftermath or rowen is then pastured or plowed under. In sections where the season is not long enough to permit the clover to set seed after a full hay crop has been harvested it is necessary if seed is desired either to pasture back the first crop of clover or to cut it early when just coming into bloom, rather than to wait until it is in full bloom, as is usually recommended. When mixed with timothy the stand is often allowed to remain three or four years with the clover gradually decreasing. If it is desired to retain a stand of clover for more than two years seed must be allowed to mature during the late summer the second season. This may reseed the area naturally, but it is well to give the ground a good harrowing to cover the seed and properly scatter it. A top-dressing with clover straw or with manure made from clover hay will also tend to thicken up the stand by reason of the seeds which are present therein. Although no definite experimental evidence is at hand it is probable that by leaving occasional uncut strips of red clover across the field when cutting the seed crop this will furnish sufficient seed to reseed the ground when harrowed across the narrow uncut strips.

NEED OF EXPERIMENTS WITH RED CLOVER.

Red clover is a well-known crop in most sections of the United States, but there is yet much that might be learned by the individual farmer in regard to the special requirements of the clover crop upon the particular fields and soils in question. By devoting a small portion of the field to experimental uses, the relative merits of a number of different practices can be readily determined. Should any of these methods prove superior to the ordinary treatment given the remainder of the field it can be used for increased areas during succeeding seasons.

Among the points that can be readily determined by experimenting on narrow strips across one end of the field are: (1) Time of seeding; (2) rate of seeding; (3) use of a nurse crop as compared with no nurse crop; (4) barley compared with oats as a nurse crop; and (5) the relative merits of different varieties of clover, different fertilizers, and different amounts of lime. Later, strips may be cut at different times to determine the effect on seed production and yield of hay.

In all such experimental strips it is important to provide a check strip to be given only the usual treatment, to serve as a definite basis of comparison in determining the relative value of the different special treatments. The accompanying diagrams illustrate this method, which is readily adapted to the determination of the value of any system of practice as compared with the ordinary method.

Suggested outlines for experiments to determine the need of clover for lime, manure, potash, and phosphoric acid.

No lime or manure.
Lime only.
Manure only.
Lime and manure.

Potash and phosphoric acid.
Potash only.
Phosphoric acid only.
Neither potash nor phosphoric acid.

The outline shown in the second diagram will be found useful in sections where it is thought that some commercial fertilizer is essential. By applying lime to a narrow strip running across the strips shown in the diagram the exact value of lime in connection with the different fertilizers can be definitely determined.

These outlines are given primarily to illustrate the principle of definite experimentation and the method can be used to determine which is the best of any series of practices for a particular set of conditions.

HANDLING THE RED CLOVER CROP.

RED CLOVER HAY.

Time of cutting red clover hay.—In order to obtain the best hay, the clover crop should be cut, as a general rule, when just past full bloom. At this stage a maximum of protein and dry matter is present, the leaves are still intact, and the stems green. After this stage the leaves begin to fall and the protein content is in other ways reduced. It frequently happens, however, that due consideration for the success of the second crop, which is usually allowed to stand for seed, makes it necessary to cut the first crop somewhat earlier than at the best haying stage in order to avoid injury from certain insect enemies. The disadvantages of cutting hay before it is in full bloom are due to the fact that the young growth is then quite sappy and considerably more difficult to cure into a good quality of hay.

Methods of harvesting red clover hay.—The methods of harvesting red clover hay vary somewhat in different sections of the country. In general it is desirable to so handle the hay that it will reach the barn or stack with the least possible exposure to the weather and the minimum loss of leaves. Clover should not be allowed to become too dry in either the swath or the windrow, else the leaves will crumble, resulting at best in a very dusty hay, to say nothing of the actual loss of much of the nutritive value. If the hay can be cocked before the leaves are entirely dry the movement of the water from the stems through the leaves will continue. When the leaves become well wilted in the swath it should be raked into windrows and then bunched into cocks when the hay is about half dry. Each cock should contain only enough hay so that two men can place the entire cock on the wagon at once, as in this way the loss of leaves due to handling is reduced to a minimum. Where a prime or choice quality of hay is desired and the rains are frequent hay caps for the cocks and canvas covers for any outside stacks are valuable devices. These hay caps can be made from a 40-inch square of canvas or ducking and may be held in place by small weights attached to each corner. Cement weights about the size of a baseball which may be attached to the hay cap by means of a hook and eye are satisfactory. Any excess of clover hay is usually baled for the market, but under ordinary circumstances the farm produces only enough hay to maintain the live stock which the place supports.

One successful method of curing hay in use by a Tennessee farmer is to cut when half the blossoms are dead. The mower is run the entire day; the next morning, after the dew is off, the hay is raked into windrows, put into medium-sized cocks, and allowed to remain for 24 to 36 hours. The hay is forked over once to prevent heating and is then put in the barn. In threatening weather the hay is put into the barn at the end of 24 hours, but it is preferable to leave it in the field for a somewhat longer time.

Another method which has been locally successful under favorable conditions is to mow as soon as the dew is off, endeavoring by 11 o'clock to have enough cut to last the haulers from 1 to 5 o'clock in the afternoon. The newly cut clover is shaken up with a tedder before noon; at 1 o'clock it is raked into windrows, immediately bunched with the rake, and hauled into the barn. By this method the hay remains warm and free from outside moisture. The hay must be put in before 5 o'clock or the falling dew will deposit sufficient moisture to cause molding in the barn. Handled in this way clover loses none of its leaves; but it is necessary to use extreme care in not having any outside moisture on the hay, or heating in the mow is apt to take place. For this method to be a success excellent haying weather is necessary. It frequently happens that repeated rains make a prime quality of hay out of the question where the hay is to be cured in the field. In extreme cases the silo is to be recommended as a means of making the best utilization of the rain-threatened hay crop.

Importance of the leaves for hay.—A considerable percentage of red clover leaves is apt to be lost during the haying process, owing to their tendency to crumble if dried rather than cured. The leaves are much richer in protein than the stems; while they constitute on an average only about 40 per cent of the total weight of the plant, they contain nearly two-thirds of the protein of the whole plant. Owing to improper methods of harvesting and to untimely rains one-half of the leaves may be lost, thus resulting in a marked deterioration in the feeding value of the hay. Table I indicates the results of the analyses of hay from a single plant of red clover cut when one-fourth the blooms turned brown and cured under cover.

TABLE I.—*Results of analyses*[1] *of the different parts of the red clover plant.*

Constituents.	Heads.	Stems.	Leaves.	Leaf-stalks.
Protein....per cent..	18.25	8.06	24.63	11.16
Moisture....do....	9.99	8.02	8.70	8.88
Ash....do....	7.20	5.67	8.39	8.02
Ether extract (fat)....do...	2.86	1.25	5.00	2.18
Crude fiber....do ..	10.29	34.94	13.36	13.08
Nitrogen-free extract....do...	51.41	42.06	39.92	56.68

[1] Analyses made by the Bureau of Chemistry.

Stacking red clover hay.—The same general rules used for stacking other hays apply to the stacking of red clover hay; but it must be remembered that red clover sheds water much less readily than the grasses and for this reason greater care is necessary in building and protecting the stack from the action of rain. It is advisable to build some kind of foundation for the stack. This foundation may be composed of poles or rails or other less valuable hay. By care in stacking a comparatively large bulge may be put on the sides of the stack. This reduces the proportion of the hay in the stack bottom and causes the rain to drain off at some distance from the base of the stack. By keeping the middle full and well trampled the hay in settling will settle in such manner as to cause the water to run off rather than into the stack. As red clover absorbs moisture readily that which lies next to the ground is almost sure to be spoiled. If canvas covers are not available for covering hay which must be left outside, it is an excellent plan to top out the stacks with green grass, straw, or millet. After the stacks have settled they should be retopped with more grass or straw, placing an additional layer as far down the sides of the stack as possible. This materially reduces the amount of clover hay exposed to the elements.

When the hay is stacked or stowed away in the barn in a slightly damp condition it is sometimes the practice to mix salt with the same for the double purpose of salting the animals and preventing mold. If the clover must be put up when thought to be a little too green, alternating layers of straw will do much toward absorbing the excess of moisture.

Brown clover hay is made by stacking or mowing away the hay when it has just reached the wilting stage. The air is excluded and it becomes a compact mass. The hay must be free from external moisture if heating is to be avoided. There is therefore some danger of spoiling when this process is attempted by those unfamiliar with the process. This method has a further disadvantage in that the hay is very heavy at the time when it must be handled for stacking.

Spontaneous combustion of red clover hay.—When red clover hay is stacked or mowed away with any external moisture on it, such as dew or rain, heating is inevitable until not only the hay itself is damaged, but the heating process may go so far as to cause the entire mass to ignite and burn down the stack or the barn in which the hay has been placed. The absence of air from the mass of heated hay in a barn is often the only thing which prevents it from breaking into a flame, and such instances are made manifest the following winter by the finding of charred masses within the interior of the mow.

RED CLOVER FOR ENSILAGE.

Red clover may be so readily utilized as pasture or hay that as a rule to ensile it is not advisable; but if inclement weather ensues at the time of cutting for hay it is often advisable to ensile if the facilities are at hand. To make an ideal ensilage the crop should be cut a little earlier than is customary when cutting for hay, but early cutting is usually impracticable if hay is preferred, as the crop will be left uncut several days awaiting favorable haying weather. Although the uncured plants are heavy to handle to ensile them presents the advantage of retaining all their leaves. If sweet silage is desired, it should be dried for an equivalent of three hours of good haying weather before being put into the silo. If a feed cutter is available the clover should be cut before putting it into the silo. The second crop of clover when ensiled is best if mixed with some of the grasses or with Indian corn. The pure red clover silage is apt to be slimy. The more thoroughly it is packed down in the silo when filling the less likely it is to spoil.

RED CLOVER AS A SOILING CROP.

Where pasturing is impracticable, red clover is often used as a soiling crop—that is, cut and fed green to live stock. Use in this way reduces or eliminates the danger from bloating which attends the use of red clover as pasture. It makes a good early feed, is palatable, and from 6 to 10 tons of green feed per acre is not an unusual yield.

RED CLOVER AS PASTURE.

Red clover is a most excellent pasture for all stock, especially when they are growing. For pigs it should be supplemented with a small grain ration, as this will induce much more rapid gains. The early growth of red clover is less nutritious pound for pound than when nearing or at the blooming stage, since in the early stages of growth it is high in moisture content, thus requiring the animals to eat relatively larger quantities. Furthermore, close early pasturing is injurious to the stand of clover.

Ordinarily red clover will furnish some pasture during the first fall after spring seeding. It should not be too closely grazed at this time else the succeeding season's hay crop may be decreased. The plants should rather be allowed to go into the winter with some growth upon the crowns in order to prevent their winterkilling and also to enable them to store up material in their roots for an early vigorous growth the following spring.

Bloating.—When pasturing cattle or sheep on red clover, care must be taken not to pasture when the animals are very hungry, especially when the red clover is young and succulent or when wet with dew or rain, as bloating may result. Should bloating occur, several remedies are usually at hand which will afford material relief. A large bit, the diameter of a pitchfork handle, may be tied in the mouth; a piece of rubber tubing may be passed through the mouth to the first stomach; or, as a last resort, the animal may be tapped to allow the escape of gas. For this purpose a trocar, such as is used by veterinary surgeons, is best; but in the absence of this, a small-bladed knife may be used to make the incision about 6 inches in front of and slightly below the left hip bone. A straw or quill may be used to permit the escape of gas. Care should be taken not to allow the straw or quill to work down out of sight into the incision.[1]

RED CLOVER AS A FEED.

All farm animals require protein in some form in order to make their best growth or to produce the best results either in the form of milk and butter, as in the case of dairy stock, or as eggs, in the case of poultry. The ordinary roughage, such as corn stover and ordinary grass hay, is low in the necessary protein. On many farms this protein is supplied by feeding such concentrates as bran, oil meal, or cottonseed meal; but these concentrates are expensive and on most farms should be in large measure replaced by a leguminous forage crop, such as red clover, which can be grown on the place.

Red clover is one of the most highly nutritious forage plants, either in the green state or cured as hay. Tables II and III show the results of experiments to determine the relative values of several different kinds of feed.

TABLE II.—*Average composition and digestibility of red clover and other forage plants.*

Designation of data.	Fresh clover.	Fresh alfalfa.	Clover hay.	Alfalfa hay.	Timothy hay.	Cowpea hay.
COMPOSITION.[1]						
Number of analyses	43	23	38	21	68	8
Constituents:						
Water .... per cent	70.8	71.8	15.3	8.4	13.2	10.7
Ash .... do	2.1	2.7	6.2	7.4	4.4	7.5
Protein .... do	4.4	4.8	12.3	14.3	5.9	16.6
Crude fiber .... do	8.1	7.4	24.8	25.0	29.0	20.1
Nitrogen-free extract .... do	13.5	12.3	38.1	42.7	45.0	42.2
Ether extract (fat) .... do	1.1	1.0	3.3	2.2	2.5	2.2
DIGESTIBILITY.[2]						
Number of experiments	2	2	46	28	26	2
Constituents:						
Protein .... per cent	67	81	55	73	48	65
Crude fiber .... do	53	45	49	43	52	43
Nitrogen-free extract .... do	78	76	69	66	63	71
Ether extract (fat) .... do	65	52	53	54	57	50

[1] In part from Henry's "Feeds and Feeding," Appendix. [2] Experiments with ruminants.

TABLE III.—*Digestible nutrients in and feeding value of red clover and other forage crops.*

Kind of forage.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Feeding value per ton.
		Protein.	Carbohydrates.	Ether extract (fat).	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh clover	29.2	2.9	14.8	0.7	$5.96
Fresh alfalfa	28.2	3.9	12.7	0.5	7.00
Clover hay	84.7	6.8	35.8	1.7	14.12
Alfalfa hay	91.6	11.0	39.6	1.2	20.16
Timothy hay	86.8	2.8	43.4	1.4	9.64
Cowpea hay	89.3	10.8	38.6	1.1	19.76
Wheat bran	88.1	12.2	39.2	2.7	22.07
Shelled corn	89.1	7.9	66.7	4.3	20.16

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[1] See "Diseases of Cattle," a special report of the Bureau of Animal Industry.

The last column of Table III shows the actual feeding value of the eight different kinds of feed. These figures are based on the amount of digestible nutrients present in the respective feeds, the following money values per pound being assigned as a basis of calculation: Protein, 6.74 cents; carbohydrates (starches, etc.), 0.64 cents; ether extract (fats), 1.12 cents. These figures are merely relative, as the prices of the food elements vary somewhat in the different sections and from year to year. It will be noted that clover hay is worth nearly one-half more per ton than is a similar grade of timothy hay.

RED CLOVER IN MIXTURES.

For ordinary farm purposes it is very often advantageous to seed red clover in a mixture with other clovers and tame grasses. The root systems of the different species are not the same, and as a result the soils of both the upper and lower layers are more fully occupied than they would be by a stand of a single crop. In case the stand is to be used for pasture, the mixture will usually insure better succession of good pasturage than would the use of any single crop; that is, by proper selection of the constituents of the mixture it is possible to obtain a pasture which will provide for early as well as late grazing and at the same time give fair returns during the heated months of summer. Probably the most common mixture is red clover and timothy. In the Ohio River section and westward it is customary to seed the timothy with winter wheat and follow this up the next spring with red clover on the new stand of wheat when the ground is honeycombed by frosts. In the spring-wheat section the timothy is seeded with the red clover at the same time the wheat is sown. The timothy is longer lived than the red clover, and as a result the proportion of timothy in the mixture of the hay increases very rapidly after the second season. Ordinary red clover matures about two weeks earlier than the timothy, and for this reason the Mammoth clover, being about two weeks later, is frequently used for seeding in mixtures with the timothy. Other mixtures suitable for hay are red clover combined with orchard grass, tall meadow oat-grass, and a small admixture of alsike clover. In any low places which may exist in the meadow it is advisable to replace the orchard grass with redtop and at least half of the red clover with alsike. At the North Dakota experiment station red clover seeded alone produced an average of 3,265 pounds per acre, whereas a mixture of red clover and timothy averaged 3,356 pounds per acre. Each of these weighings included only the first cutting; if the second cutting had been included the red clover seeded alone would have given a considerably larger total, as timothy produces little second growth. On rough-land pastures red clover may also form a minor constituent of a regular mixture of bluegrass and white clover.

EFFECT OF RED CLOVER ON THE LAND.

The clovers have been justly ranked as the principal foundation of a permanent system of agriculture in the northern and eastern United States. By the proper utilization of the clover in the rotations it is possible permanently to maintain the supply of nitrogen and humus in the soil. The fertilizing value of red clover is not entirely in the hay which would be plowed under if the crop were to be used for green manure. Experiments show that 30 to 50 per cent of the fertilizer value of the clover may lie in the roots and stubble which are plowed under, even though the hay crop is removed. In one experiment the Delaware experiment station found that the red clover produced on an acre contained 122 pounds of nitrogen, 68 pounds of potash, and 28 pounds of phosphoric acid. At present prices for fertilizers one ton of clover hay contains nearly $10 worth of fertilizing elements. It frequently happens that the yields of grain crops are increased as much as 10 bushels to the acre by turning under clover sod, but too much must not be expected of red clover. The only real addition it makes to the land is the humus it supplies, together with the nitrogen it is able to extract from the air. The other fertilizer elements, such as potash and phosphoric acid, must needs be drawn from the soil itself. As soils commencing to give low yields are likely to be low in nitrates, the use of clover will bring largely increased returns for a number of years, until the other fertilizer elements begin to be depleted. Under such conditions the clover acts in one sense as a stimulant to the soil, in that it induces the soil to give up larger quantities of the other fertilizer elements than it would otherwise be called upon to do. Inasmuch as phosphoric acid and potash are not added to the soil by the growth of red clover thereon, it is ultimately necessary to supply these in the form of commercial fertilizers or in the form of barnyard manure, from time to time. By feeding the crops on the farm and returning the manure to the land the fertility of the soil can usually be maintained for many years without the addition of commercial fertilizers.

RED CLOVER IN ROTATIONS.

One reason for the great popularity of the red clover plant is the ease with which it lends itself to the rotations which have been practiced in the sections to which it is adapted. The fact that it lives but two years necessitates a rather short rotation on the farm, especially when the clover is seeded alone. Meadows and pastures containing clover and grass mixed are usually held three or four years, even though very little clover may remain during the last year or two. The value of the red clover on the farm makes it usually desirable that a considerable area of the farm be at all times seeded to this crop. The possibility of obtaining a grain crop during the season when the red clover is making its early growth, makes the utilization of this legume in maintaining soil fertility a thoroughly practicable one, not calling for an undue amount of special preparation or fertilizers to maintain successful stands upon the ordinary farm. If the land be in a somewhat depleted condition as regards fertility a 3-year rotation with clover is best, although on better soils a 4-year or even a 5-year rotation may be practicable. The Illinois experiment station has shown as a result of a 30-year test that corn on land continuously has produced 25 bushels to the acre; corn alternated with oats, 43 bushels; while corn, oats, and clover in a 3-year rotation gave a yield of 59 bushels for the corn.

Clover in rotation with corn, oats, and wheat.—A common rotation in the clover belt is corn followed by oats which in turn are followed by wheat. The wheat in turn acts as a nurse crop for the clover sown with it. After clover has stood two years the clover sod is plowed down for corn again. There has been for some time a tendency on the part of farmers to discontinue the wheat crop on the farm wherever possible, owing to some uncertainty in the results. When wheat is eliminated from the rotation the clover is seeded at the same time with the oats in the spring. Under certain conditions a second crop of corn may replace the oats in the rotation. The oats may be eliminated without substituting any crop, making the rotation corn, wheat, and clover—a 3-year rotation adapted to soils which are hardly strong enough to stand three crops between the clover crops. The substitution of the second crop of corn for the oats is made if additional corn is required, as for carrying an increased number of hogs.

Clover in rotations including rye.—Rye may be substituted for wheat in the rotations already discussed. It has some points of advantage over wheat in that it grows taller and stools less and therefore does not shade the clover so much. The seed is sown in the spring under usual conditions. The harrow may be used on the rye to cover the clover, the same as on wheat, and likewise the disk harrow or drill. One method is to seed the clover on the rye and then to pasture it early with hogs. The trampling of these animals over the field will work much of the seed into the ground and make a stand more certain. A top-dressing of manure or straw or the use of commercial fertilizer can be used in connection with the rye the same as with wheat. The rotations including rye are on much the same general plan as those with wheat.

Clover in rotations with spring-seeded cereals.—In sections north of the winter-wheat belt it is usually the practice to seed the clover with spring-sown grain. It is manifestly impossible to rely on frosts to cover the seed, as the ground must be comparatively warm before being worked for the reception of the grain crop. In some cases, as for instance if the soil is so sandy as to call for the seeding of the clover to a depth of 2 inches, the clover seed may be drilled in with the grain at one operation. On heavier soils and where a covering of only an inch is required, the seeding may be made broadcast either before or after the drill, or by a seeding attachment on the drill. The seed should be covered with a harrow following the drill, as it is usually impossible to cover the seed deeply enough if seeded in front of the drill shoes. It is often advisable on light soils to follow the harrow with a roller which firms the ground around the seed, inducing prompt germination. A corrugated rather than a smooth roller is to be preferred. It is necessary to seed the grain crop somewhat lighter than if clover were not seeded with the grain. Barley stools less than either oats or wheat and on this account is more desirable as a nurse crop. Oats are especially bad about stooling broadly and shading out the young clover plants. When the grain crop comes into head close watch must be kept of the moisture condition of the soil, as, if there is any considerable lack of rain, the grain crop should be cut for hay or at least somewhat before it would ordinarily be cut for grain. Unless this is done the young clover plants may be robbed of their much-needed moisture; but sometimes the grain crop may be considered the more important of the two if either has to be sacrificed.

Rotations containing cowpeas or soy beans preceding wheat and clover.—In sections where cowpeas and soy beans are successfully produced it is sometimes the practice to introduce one of these coarse legumes immediately preceding the wheat crop. The vines are either cut in time to have the ground ready for fall seeding or the entire pea or bean crop is rolled down and then cross-disked. The accumulation of the cowpea or soy bean stems and leaves on and near the surface serves as a mulch which acts very beneficially on the clover. The practice of turning the entire crop of both pods and vines back to the soil, however, is somewhat wasteful and it is better to pasture the pods off with hogs. This method allows only the vines to go back to the soil, thus giving the same results as regards the crop of clover besides converting a portion of the crop into pork.

Rotations of corn and clover only.—This type of rotation is not common, as it requires considerably more labor than other methods already outlined. The rotations usually are two crops of corn followed by a clover crop lasting either one or two years. The clover in such rotations is sown either in the corn at the last cultivation or in the spring in the stubble without a nurse crop. Both of these methods are open to objections on the part of average farmers. Under ordinary conditions the first method, that of seeding in corn at the last cultivation, is uncertain, especially if there are no rains at the time of seeding; but on rich black soils when especial care has been taken to have the land in fine condition it is proving successful. (Fig. 9.) On average soils and with the average tillage which the cornfields receive, it is not to be recommended to the average farmer except in a small way as an experiment. The second method, that of seeding in the spring without a nurse crop, has been found to be a very certain method of getting a good stand of clover. This method gives the clover the entire use of the ground from the start, and unless the ground is infested with weeds the clover makes a very good growth the first season and will give a fair cutting of hay. Clipping in early summer will often overcome the evil effect of weeds. This method, however, is not to be advised on soils badly infested with weeds, as the weeds will usually do more injury to the young clover than the customary nurse crop of grain.

Clover in rotations on farms not carrying live stock.—The rotations already discussed are especially adapted to farms carrying sufficient live stock to consume the hay and roughage produced on the farm. Under conditions where such a system of farming is not feasible a modification of the clover rotation is essential. This may be brought about by the use of Mammoth clover in the rotation. Since this produces but one crop it should be a crop of seed. This will bring in favorable seasons a very good cash return from the ground, and the clover straw and chaff may be returned to the land and plowed under. The actual quantity of soil fertility carried away with an ordinary crop of clover seed is comparatively small. After the crop of seed is removed and the straw again scattered over the field the land may be immediately put into some other crop. There will be less clover straw to scatter if the stubble is cut high so as merely to get all the heads. In some sections grain headers are in successful operation where the clover fields are large. (Fig. 12.)

Rotations including cotton.—Although cowpeas and soy beans are the customary soil improvers throughout the South, certain conditions exist, especially on the black prairie soils, where red clover may serve as an important crop in alternation with cotton. The clover can be seeded in the cotton just before or after picking time and will make sufficient growth for a crop of hay by the time the cotton is to be reseeded the next spring. The stubble can be worked up in connection with the fitting of the ground for cotton.

SEED PRODUCTION OF RED CLOVER.

The extensive production of red clover in this country is due to the production of a few acres on a large number of farms rather than to the production of large areas on farms devoted primarily to this crop. For this reason the clover crop is too often an incident and not the main issue on the farm. The various successful experiences of occasional farmers in sections where the average production of red clover seed is very low indicate that much is to be learned regarding the essentials of the successful production of the crop of red clover seed. Where these essentials are understood, it is usually not hard to provide for them and thus materially increase the seed crop. In practically all of the areas adapted to the production of red clover hay fairly satisfactory crops of seed are also produced. Red clover differs in this respect from alfalfa, which is grown for hay over extended areas where seed production is not practicable.[1]

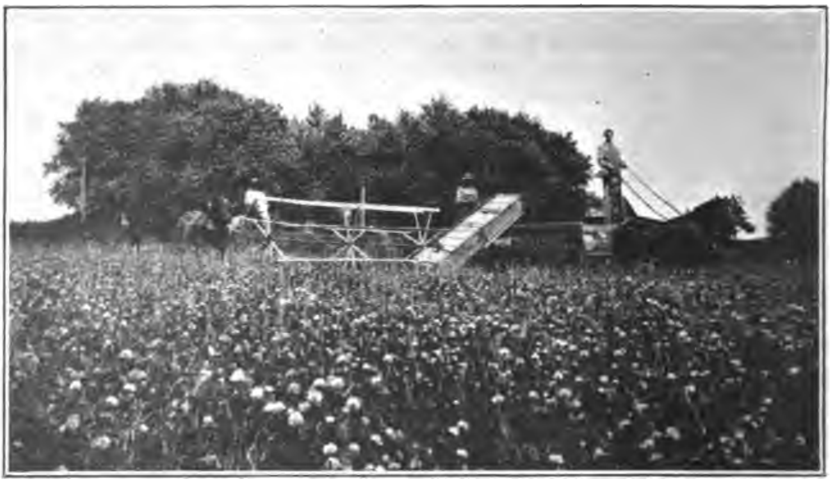

FIG. 12.—Grain header at work in a clover field.

HANDLING CLOVER FOR SEED.

In order to produce the best crops of seed the conditions should be such as to retard somewhat the production of the largest vegetative growth, as the conditions which will produce a medium growth of the plant will usually induce the best set of seed. When the growth of the clover is so rank as to lodge, the heads are apt to be comparatively few and not well filled with seed.

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[1] See Farmers' Bulletin 339, entitled "Alfalfa," by J. M. Westgate.

The time of cutting the first crop for hay has a marked effect on the second crop, which is the one usually allowed to stand for seed. As already indicated, the best hay is produced when the crop is cut a little past full bloom; but this may or may not be the best time within a given section to cut the first crop, if due consideration is given to the production of maximum yields of seed where seed is relatively more important than the difference of a few days in the time of cutting the hay crop. For the sake of the succeeding seed crop the first cutting for hay should be made a little before full bloom rather than after the first blossoms have begun to turn brown. As a specific instance it may be cited that mowing was commenced on one side of a 40-acre clover field when the plants were two-thirds in bloom. Several days were required to cut the field and the last of the clover was not cut until the plants were just past full bloom. The effect of this time of cutting on the seed crop was remarkable in that the early cutting induced the second crop to produce seed at the rate of 5 bushels per acre, whereas the cutting a week later resulted in a subsequent seed yield of only 2 bushels. The difference in the value of the preceding hay crop by reason of the early cutting on the one side was probably not more than 20 per cent, whereas its increase of the yield of seed was more than 100 per cent.

A number of conditions may arise which make it inadvisable to attempt to produce a full crop of hay if it is desired to produce a maximum crop of seed.

In the Ohio Valley States the ravages of the various insect enemies may be materially checked by pasturing the clover or even by clipping it considerably earlier than is demanded by the hay crop, as this process tends to destroy insect enemies which would otherwise be developing to work havoc in the succeeding seed crop. In the northern portion of the northern tier of States the short growing season will not usually permit the first crop to reach full bloom and still allow time for the maturing of a seed crop. For this reason it is usually necessary to pasture the crop or cut it earlier than would otherwise be necessary. If a full cutting of the first crop of clover is made for hay and the second left for seed, the seed yield is likely to be disappointing on account of the lack of suitable growing weather for the seed crop. In the latitude of northern Michigan the clover may be pastured until June 18 or 20 in normal seasons and then allowed to produce seed. If stock for pasturing is not available, the clover may be clipped back about the middle of June with equally good results. Even when the land is pastured it is a good practice to run the mower over the field after the stock is removed to clip back any bunches which may be left by the stock. In this way the seed crop will mature much more evenly over the entire field. The reasons for the increase of the seed yield due to clipping or pasturing back are not well understood. It is claimed by some that this brings the setting of the seed at a time when the necessary dry weather is apt to be prevalent. Another reason is the avoiding of injurious insects which would be present if the clover had matured a few weeks later. Another reason is that if pastured or clipped back the plants do not grow so rank and are less likely to lodge and fall down, thus enabling them to bloom more freely with a consequent larger seed crop. Another advantage is in having much less straw to handle at thrashing time.

ESTIMATING THE PROBABLE SEED CROP.

Inasmuch as the clover straw is of little value as hay, if the crop is allowed to go to seed a decision must be made when the field is a little past full bloom as to whether the second cutting should be allowed to stand for seed or be used for hay. It is usually possible to estimate with fair accuracy the probable seed production by the time the plants are well out of bloom. If examination of the field shows a uniform stand of a goodly number of heads with an average setting of 25 or 30 seeds to the head, it may be taken as an indication of a sufficiently good crop to pay for the seed, as under normal conditions this indicates a yield of 1 to 2 bushels per acre. If the heads which are turning brown show less than 20 seeds to the head, it will usually be better to cut the crop for hay even though it is a little too late for the best quality of hay.

HARVESTING THE RED CLOVER SEED CROP.

Under normal conditions the stand of red clover should be cut when the heads have turned dark brown and most of the seeds have reached the dough stage. If left much later than this stage the heads become brittle and break off in the process of harvesting. On the other hand, it is inadvisable to cut the clover when the seeds are in the soft dough stage, expecting them to ripen after cutting, as light, shriveled seed is likely to result. If the clover is a little overripe, the loss of heads may be materially reduced by cutting early in the morning or in the evening, when the straw is less brittle by reason of the dew. The red clover should be cut as high as possible, as this will enable thrashing to be done with less trouble from the straw. Headers similar to or identical with the grain headers are sometimes used. (Fig. 12.) Many farmers use a mower with a fingerlike attachment behind the cutter bar for bunching the clover behind the wheels, so as to be out of the way of the trampling of the horses on the next round. Another buncher is tripped by the foot, the guide rods pushing the hay partly to one side before the buncher is tripped. In the absence of such an arrangement, the ordinary mower may be followed by men who remove with barley forks the clover from the path of the mower and horses. An old-fashioned self-rake reaper is probably as satisfactory an implement as can be used. In many cases, however, no special devices are used to prevent injury by the mowing-machine wheels and the trampling of the horses.

The bunches left behind the mower may be allowed to remain as they are or may be piled two or three together. The cocks must be watched in rainy weather. If they become moist, the seed is apt to sprout. It must be remembered that the less handling the clover is given the less will be the loss of seed from shattering. Danger of the seed sprouting is incurred if the clover continues damp, but hulling is greatly facilitated if the clover is alternately somewhat wet and dry. It usually requires at least four days to properly cure for hulling, although two weeks or more may intervene between cutting and hulling. It is the common practice to hull directly from the field, as hulling from a stack or barn calls for extra handling with attendant loss of seed. On the other hand, a heavy seed crop may often be put under cover to advantage, especially if the season be rainy. It is the usual custom to hull the seed with a special red clover huller. In principle this machine acts as an ordinary grain thrashing machine in removing and breaking up the heads, which are then passed underneath the cylinder where the individual clover seed pods with the inclosed seeds are rubbed out by rasps or other special devices. (Fig. 13.) The huller will not do good work when the clover is at all damp even from dew; hence six hours is usually found to be a good day's run when hulling from the field. A grain thrasher with a clover attachment is sometimes used, but this is less satisfactory because it is often necessary to run the material through twice. A further disadvantage is that the thrashing machine is likely to be required for grain thrashing at the time the red clover should be hulled.

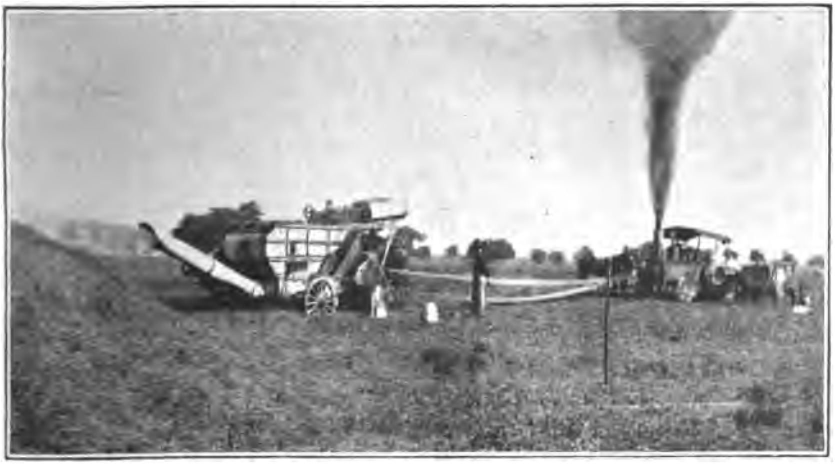

FIG. 13.—Clover huller at work.

UTILIZATION OF CLOVER STRAW.

The clover straw after the seed has been removed from it is too coarse and unpalatable to be of much value as feed, though sheep and cattle will pick it over during the winter. It may be scattered back on the field with good effect on the land. The chaff may also be used as an absorbent of liquid in stables. It is an excellent plan to apply the clover straw and chaff to thin spots in the fields which are to be in clover the succeeding year. This method materially improves the inoculation and tends to increase the productivity of the clover and other crops.

If the clover is cut for seed and cured without having been rained upon, the straw has some feeding value, but such instances are unusual.

RELATION OF POLLINIZING INSECTS TO THE PRODUCTION OF RED CLOVER SEED.

Numerous experiments have shown that if the heads of red clover are bagged to exclude insects little or no seed is produced, indicating that without external assistance of some kind the red clover plant is unable to set seed. It is not necessarily sterile to its own pollen, as experiments have shown that if the flower's own pollen be rubbed into the stigma, imitating the action of a bumblebee in visiting the plant, seed will be produced. Under field conditions, however, it is necessary to rely upon the visits of insects for the successful setting of the seed crop. Machines are being experimented with which imitate the action of the bumblebee and which may eventually place the seed crop upon a more certain basis, as at present the absence of suitable pollinizing insects usually reduces the crop of clover seed. Bumblebees are commonly supposed to be the most efficient agencies in the pollinization of red clover. When the bee alights on the clover head, its weight presses down upon the keel, forcing out the stigma (female) which becomes dusted with the pollen (male) that is already adhering to the under surface of the bee. It is probable that in a majority of cases it is pollen from some other red clover plant which is brought into contact with the stigma and in this way cross-pollinization seems to be the rule.

VARIETIES OF RED CLOVER.

There are a number of varieties of red clover, each more or less adapted to some special purpose or to certain sections.

Ordinary red clover.—Red clover (*Trifolium pratense*) is the most important member of the group of true clovers, although there are other important varieties and species. Under conditions where red clover succeeds it is the best general-purpose clover. It will usually produce both a crop of hay and a succeeding crop of seed in the same season. It has the further advantage of succeeding under ordinary conditions when seeded in connection with a grain crop, thus calling for very little extra labor when it is desired to establish a stand on the farm.

Mammoth clover.—Mammoth clover, also known as Sapling clover, Pea Vine clover, Bull clover, and Perennial clover, is only a form of the ordinary red clover and is not sufficiently distinct botanically from *Trifolium pratense*, the ordinary red clover, to receive a botanical varietal name. It is not the "zigzag clover" of northern Europe, known as *Trifolium medium*, which latter name has often been misapplied to Mammoth clover. Mammoth clover is about two weeks later in maturing than the ordinary red, and it is partly owing to this fact that it is impracticable to harvest both a hay crop and a seed crop the same season. Mammoth clover is useful in seeding with timothy for hay, because it and the timothy bloom at the same time, whereas ordinary red clover blooms too early for the best results in cutting the timothy. The large size of Mammoth clover plants makes them of slightly greater value as a soil improver, and in addition the seed yield is usually larger. The one crop of Mammoth clover is somewhat less than the two crops of ordinary red clover, but may be more economical owing to the greater cost of harvesting two crops of the ordinary clover. On low ground the stems of Mammoth clover are apt to become somewhat woody. It grows less rank on poor soils, where it is ordinarily grown, rather than on the heavier soils. Furthermore, on the poorer soils it is excellent as a seed-producing crop, being used in a rotation of corn, grain, and clover, each one year; the Mammoth clover is allowed to stand for seed and no attempt is made to utilize the hay other than for returning fertility to the land. The variation in the time of maturity of this clover enables it to avoid many of the insect pests which greatly injure the fields of ordinary clover. This item is important in reducing the injury from many of the insects which play havoc with the successful production of seed of the ordinary red clover. The seed of the Mammoth clover is slightly larger than and is recommended above either the ordinary or alsike on poor sandy lands in the North. If grown for hay it should be cut when in early bloom, rather than when past bloom, on account of the tendency of the stems to become woody. In the northern part of the tier of Northern States where only one crop of ordinary clover is possible Mammoth clover is usually preferred on account of its higher yield.

Russian red clovers.—Most of the red clover grown in Russia is without the hairs which are usually present on the stems and leaves of both the ordinary red and Mammoth clovers. This smoothness is apparently a distinct advantage because the hay is rendered much less dusty. These clovers do not appear to be so well adapted to growth farther south and they are quite as late in maturing as the Mammoth clover. The first cutting in the Northern States will usually exceed the ordinary variety, but like the Mammoth clover it produces little or no second crop. Seed of these Russian clovers is not usually available on the market.

Special forms of red clover.—In addition to the three varieties of red clover already mentioned certain disease-resistant strains are being developed which may prove of material value in overcoming some of the handicaps under which red clover labors where diseases are present which hinder its growth; but these strains are produced to such a limited extent that the seed is not yet on the market in commercial quantities. Preliminary results with these strains suggest the possibility of developing certain forms of red clover adapted to the peculiar conditions which are present in many sections of the country.

OTHER SPECIES OF CLOVER COMPARED WITH RED CLOVER.

TRUE CLOVERS.

White clover.—The low-growing, shallow-rooted white clover (*Trifolium repens*) is adapted only for pasturage, as it does not attain sufficient height to be mown for hay. The seed crop matures in July and August in the Northern States. Yields of seed vary from 2 to 6 bushels per acre, and the price is about the same per bushel as that of red clover. A 2-year rotation of barley one year followed by white clover for seed the second is common in central-eastern Wisconsin. Elsewhere it is usually seeded in a mixture with bluegrass and rarely if ever causes bloat as red clover is apt to do.

Giant White or Ladino clover.—A tall-growing variety of white clover (*Trifolium repens* var. *lata*), first experimented with in this country by the North Carolina experiment station, was procured in Italy and may be imported thence in limited quantities. It grows several times taller than the ordinary white clover but not so tall as either the alsike or the ordinary red clover. It furnishes an excellent yield of good pasturage and makes sufficient growth to be cut for hay. The stems grow prostrate and only the elongated leafstalks and leaves are used for hay, which is a very nutritious feed but is somewhat hard to cure.

Alsike clover.—Intermediate in general appearance between the white and red clovers, and erroneously supposed to be a hybrid between the two, is alsike clover (*Trifolium hybridum*), also called Swedish clover. Alsike is especially adapted to wet soils and also to soils which are too low in humus to grow red clover to advantage. Seed may be taken from the first crop, although an early clipping (especially if the spring is unusually wet) will usually result in a better crop of seed. The blooms are excellent as honey producers. In comparison with red clover, which lasts only two years, the alsike lasts for three to five years or even longer. The seed is much smaller and 4 to 8 pounds per acre is an ample seeding. The hay is somewhat richer pound for pound than the ordinary red clover, but only one crop is procurable and this is not generally as heavy as even the first crop usually produced by the ordinary red clover. It is hardier than either the Mammoth or ordinary clover, but lodges worse than either. For this reason it is usually best to seed it in mixture either with ordinary red clover or with orchard grass to prevent its lodging. In some sections where red clover is no longer grown successfully the farmers have been forced to adopt the alsike. The continuous use of pure alsike clover either as pasture or as hay has a tendency to produce sores on both horses and mules.

Crimson clover.—Crimson clover (*Trifolium incarnatum*) is especially adapted as a cover crop and for green manure in the Atlantic States. It is easily recognized by its scarlet blooms. It is seeded in August either alone or in corn. Its special advantage lies in that its autumn, winter, and early-spring growth is sufficient so that it may be turned under in the spring following the seeding in time for another crop, such as corn or even cotton, in the South Atlantic States. It is also valuable for pasturing, soiling, or for ensilage, coming at a time when other green feed is scarce. One disadvantage in feeding the hay if cut when overripe is the tendency of the hairs, which are numerous on parts of the plant, to form hair balls in the alimentary tract of horses.

Shaftal clover.—Shaftal clover (*Trifolium suaveolens*) has recently been obtained from Persia and is not yet on the market in commercial quantities. It is usually seeded in the fall and is somewhat similar to crimson clover in its requirements and growth. The seed is as yet very expensive. Moreover it lodges badly and is difficult to cure. These disadvantages handicap its more extensive production. Ordinarily this clover is a winter annual, maturing seed and dying the first summer after seeding; but a perennial strain is reported as growing in northern India.

SO-CALLED CLOVERS.

Sweet clover.—Sweet clover (*Melilotus alba*) is often regarded as of little or no value as a forage crop on account of its bitter taste; but stock may acquire a taste for it, and then it proves a very satisfactory feed. It will grow on clay hills, on sandy stretches in the clover section, and also makes a satisfactory growth in sections where it is too dry to grow red clover. It is a biennial, living only two years, being similar in this respect to red clover. A permanent stand may be maintained by dividing the pasture and alternately grazing and mowing the two halves.

Lespedeza, or Japan clover.—Lespedeza (*Lespedeza striata*) is distinctly a southern plant and makes very small growth north of the latitude of Virginia. In the extreme Southern States it makes a growth comparable with the true clovers and is a useful plant to supplement the winter-growing clovers which do not thrive in the hot summer months as does lespedeza.[1]

Mexican clover.—Mexican clover (*Richardsonia scabra*) is not a true clover nor even a legume. It occurs principally along the Gulf coast in the Southern States. It grows spontaneously after cultivated crops are removed, being usually associated with crab-grass. The seed is not usually on the market.

ENEMIES OF RED CLOVER.

The principal enemies of red clover are insects, fungous diseases, and weeds. Occasionally burrowing rodents, such as mice and gophers, do some damage, usually not at all serious. Of the enemies just mentioned the insect pests are usually more troublesome than either the fungous diseases or weeds.

INSECT ENEMIES.

Red clover is affected by a number of insects which at one time or another during its existence tend to destroy the life of the plant. Many insects feed to a greater or less extent on the red clover plant, but comparatively few of them do enough material harm to affect seriously the production of clover over extended areas. For a full discussion of the enemies of red clover the reader is referred to the publications of the Bureau of Entomology of the United States Department of Agriculture;[2] and also to the bulletins on this topic issued by most of the experiment stations in the clover-growing States.

The clover root-borer.—For over 30 years the clover root-borer (*Hylastinus obscurus* Marsh) has done an immense amount of damage in the clover-producing States east of the Mississippi River. This insect is especially destructive in Ohio, Indiana, and southern Michigan. At one time this pest threatened the entire clover-growing industry of Michigan. The beetle has a hard body about one-sixth of an inch in length (fig. 14), and its color is dark brown. It is perhaps best recognized by the effect of the larva (fig. 15) on the root of the plant, which is shown in the accompanying illustration (fig. 16). These insects do not materially damage the stand of clover until the summer of the second year, because the roots must reach a considerable size before they are capable of harboring the beetles. It is the larvæ rather than the adult insects which work the actual destruction of the roots of the red clover. The only preventive measure yet tried is to turn down the clover stubble as soon as the hay crop is removed. At this time the root-borers are in an immature stage and deprived of their food must perish as they can not migrate. If this plowing is delayed until later in the fall the larvæ will have developed to the pupæ and adults and the plowing will have little if any effect upon them.

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[1] See Farmers' Bulletin 441, entitled "Lespedeza, or Japan Clover," by A. D. McNair and W. B. Mercier.

[2] Circular 69, Some Insects Affecting the Production of Red Clover Seed; Circular 119, The Clover Rootborer; Bulletin 85, pt. 1, The Lesser Clover-leaf Weevil; Bulletin 85, pt. 3, The Clover-root Curculio.

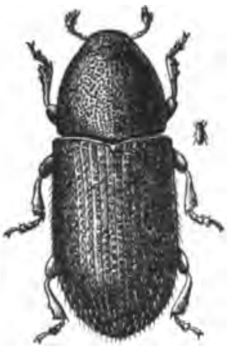

FIG. 14.—The adult insect of the clover root-borer (*Hylastinus obscurus*). A natural-size representation is shown at the right.

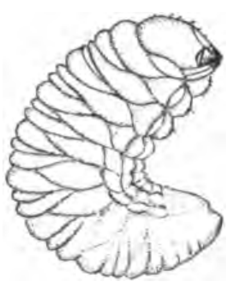

FIG. 15.—The larva (grub or maggot) of the clover root-borer. It is in this stage that the insect does most damage to the clover roots. Much enlarged.

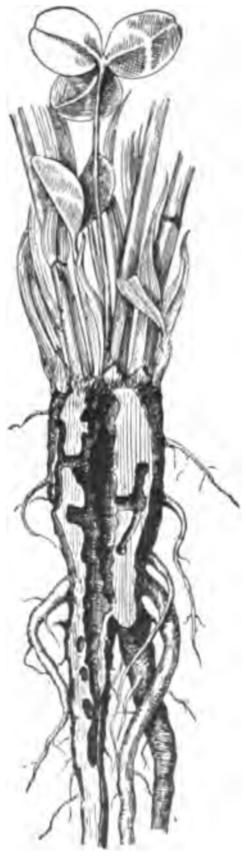

FIG. 16.—Clover root, showing the work of the clover root-borer. (Slightly enlarged.)

The clover-seed chalcis fly.—A little black wasplike insect (fig. 17) about the size of the red clover seed, known as the clover-seed chalcis fly (*Bruchophagus funebris* How.), may frequently be seen emerging from a recently thrashed crop of this seed. At present this insect is one of the worst clover pests in the United States, being largely responsible for many of the low yields of clover seed. The eggs are laid in the newly developed seed before it is entirely hardened; the larva then develops within the seed which it eats entirely away before emerging as the adult (fig. 18). It is probable that light early pasturing or clipping of the first growth in the spring will materially reduce the danger from this pest; by bringing on the seed crop later than usual the destructive work of the insects may be largely prevented.

The clover-flower midge.—Damage to the clover plant by the clover-flower midge (*Dasyneura leguminicola* Lintn.) is occasioned by the maggots (fig. 19), which develop in the florets and prevent them from setting seed. Even the flower is injured (fig. 20) in its development so that the entire field may take on a different aspect when suffering from the serious ravages of this pest. (Fig. 21.) This small insect is a near relative of the wheat midge. It may be controlled by cutting the hay quite early, as this will destroy the larvæ of the midge before they have had time to develop into the other stages. By the time the second or fall brood of the midges appears the blooms of the second crop have become too far advanced for the midges to work in them. A second method may be applied where timothy and clover are grown together. The meadows may be pastured lightly or they may be clipped back with a mower set high. This brings the blooming of the subsequent crop of clover too late for the destructive work of the midge.

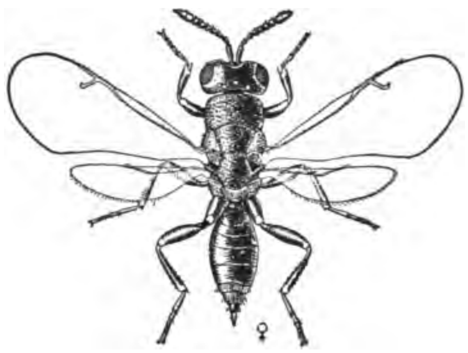

FIG. 17.—Adult insect of the clover-seed chalcis fly (*Bruchophagus funebris*). The wings are ordinarily closely folded along the back.

The clover-hay worm.—The larva of the clover-hay worm (*Hypsopygia costalis* Fab.) works in stacked or stored clover hay. It damages the hay quite as much by the silver web and particles of excrement it leaves behind as in actually eating the hay. It usually attacks the bottom of the clover stack or mow and such hay is usually refused by horses or cattle. This larva develops into a small brown moth. This insect is best controlled by burning any clover hay which is affected with it and by carefully cleaning out the old clover hay before the new crop is stored. If the hay is stacked outside and the stacks are raised above the ground, as on a foundation of logs, the injury by this insect may be materially reduced. The salting of the hay, especially at the bottom of the stack, or mow, acts as a deterrent to these worms.

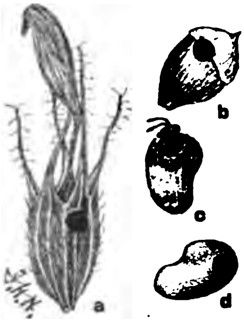

FIG. 18.—Sketch showing the effect of the clover-seed chalcis fly; calyx (*a*), seed capsule (*b*), and seeds (*c* and *d*). At *c* the mature insect is shown in the act of emerging.

The clover-leaf weevil.—Among the enemies of red clover is the clover-leaf weevil (*Phytonomus punctatus* Fab.). (Fig. 22.) The larvæ hatch in late fall and become full grown in May and the adults appear in July and August. This insect was formerly especially troublesome in Michigan until a fungous enemy of the larvæ developed to a sufficient extent to hold it in check.

One important effect of the clover-leaf weevil is that it may destroy the early foliage. A little later the clover will renew its growth without being permanently affected on account of there being no injury to the roots. This delays the flowering period until after the flower midge has laid its eggs and disappeared. In this respect it is beneficial. The temporary destruction of the early foliage will sometimes lead the farmer to think his clover field has been killed and he will plow up the stand, when really the injury is slight if the field is left alone.

FUNGOUS DISEASES OF RED CLOVER.

All the clovers are comparatively free from the plant diseases which so frequently prove disastrous to other crops; but in certain sections some of these diseases have proved serious, even to the practical elimination of successful stands.

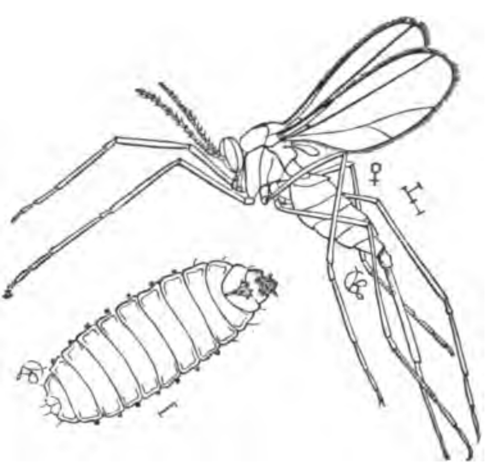

Fig. 19.—Maggot and adult stages of the clover flower midge (*Dasyneura leguminicola*). In the clover head the maggot appears as a small red object about one-twelfth of an inch in length.

A number of diseases attack principally the leaves of the red clover plant, forming large or small spots of various appearances. The clover leaf-spot (*Pseudopeziza trifolii*) appears as a multitude of small black specks on the leaves. The clover rust (*Uromyces trifolii* or *U. striatus*) shows as small reddish-brown spots on the leaves. The powdery mildew (*Erysiphe polygoni*) develops a whitish mass somewhat like a cobweb across the surface of the leaves, and close inspection shows the presence of small black bodies within the meshes. None of these leaf diseases is usually very serious and when the plants are growing vigorously they are usually able to thrive in spite of the presence of the fungous diseases.

Root-rot (*Rhizoctonia violacea*) occasionally proves destructive to the roots of the clover plant. Stem-rot (*Sclerotinia trifoliorum*) attacks the stems and is characterized by the presence of hard, dark masses of fungous tissue.

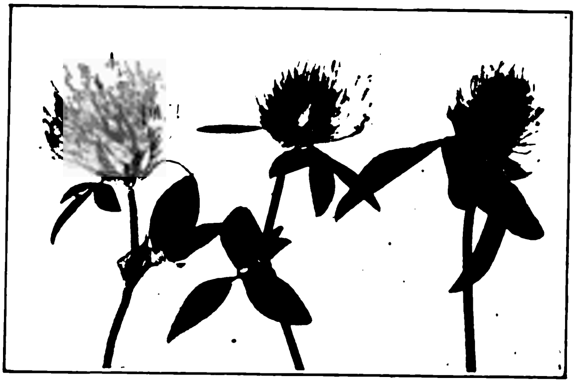

Fig. 20.—Clover heads, showing the effects of the clover-flower midge. The flower head shown at the left is unaffected, the middle head is partly affected, and the head at the right shows all the flowers destroyed by this insect.

The disease known as clover anthracnose (*Colletotrichum trifolii*) has been observed in a number of States, but its ravages have been observed to be especially disastrous only in Tennessee, where, owing to its prevalence, the seeding of red clover is said to have been practically given up. The disease is first manifested by a series of small purple patches which spread on the stem, until if at all badly affected, it is completely encircled, causing the death of the plant.

The only known direct remedy is in the development of strains resistant to the disease. Considerable progress has been made along this line by the Tennessee experiment station.

WEEDS.

The seeds of the weeds which are commonly found in red clover are shown in figure 5 (p. 10). From the standpoint of the clover plant itself buckhorn, foxtail, and crab-grass probably form the worst weeds with which the clover plant must contend. Preventive measures alone are ordinarily practicable, as eradication is too expensive except in the case of especially dangerous weeds or weeds large enough to be readily removed just before they mature their seed crop. Thistles and wild carrot plants should be thus removed.

Dodder is one of the worst weeds so far as red clover is concerned. The accompanying illustration (fig. 23) indicates the general appearance of the yellow threadlike vines which attach themselves to the clover plant. The dodder seeds germinate in the ground shortly after the clover seeds sprout. The yellow, threadlike stem of the dodder soon firmly attaches itself to the young clover plant, after which the stem connecting it with the ground withers away. The dodder lives thereafter entirely on the clover plant. Dodder is very difficult to eradicate when once established, and for this reason great care should be taken to avoid introducing it with the red clover at seeding time.[1] Close grazing has been recommended as being effective in holding dodder in check. If it appears in isolated spots through the field, it is advisable to cut the affected areas as low as possible and remove all cut material from the field. Destroying the dodder by burning with different inflammable materials has occasionally proved successful, but it is apt to be more expensive than the close cutting and removal of the affected plants.

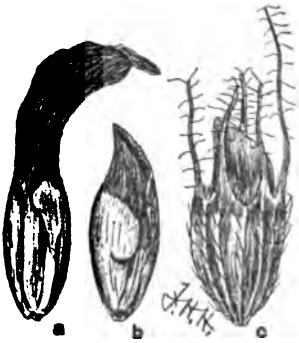

FIG. 21.—Sketch showing the effect of the clover-flower midge on the individual clover flowers: Clover corolla (*a* and *b*). The usual appearance of the shortened corolla with respect to the calyx lobes is shown at *c*.

CLOVER-SICKNESS.

Some confusion exists regarding the nature of clover-sickness, a term which appears to have been applied to a great many different causes of clover failure. In Europe this term is used to designate the condition of the land when it fails to grow continuous crops of clover but which will again grow successful crops after an interval of five to eight years. Such a condition would appear to be due either to the exhaustion of some particular element of fertility required by the clover, which would again become gradually stored up in the soil during the years when no clover was grown, or to the presence of some deleterious substance left in the soil by the clover plants, which is gradually eliminated from the surface layers of the soil.

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[1] See Farmers' Bulletin 306, entitled "Dodder in Relation to Farm Seeds."

Many sections in this country no longer grow clover as easily as it was formerly grown. Observations indicate that this failure to produce successful stands of clover is not due to any one particular cause but rather to a number of different causes, any one or any combination of which may react very unfavorably on the stand of clover. In some sections the cause of the frequently noted failures with clover has been specifically determined. In Tennessee the presence of the clover anthracnose disease appears to be the principal feature in working against the production of this crop. In Illinois the lack of phosphorus and lime in the soil (often in connection with lack of proper drainage) has been pointed out as a predisposing cause of failure to get stands of red clover. In West Virginia the presence of nematodes on the roots has been observed to react unfavorably on the stands. In other sections failures have been shown to be due to lack of sufficient quantities of lime in the soil. A primary cause of clover failure which is coming more and more to be recognized lies in the depletion of the original humus supply in the soil by repeated croppings and insufficient return to the soil by means of manure and other vegetative matter. This depletion of the humus makes the soil nonretentive of moisture in time of drought, reducing the growth of the clover plants and rendering them more liable to the attacks of any diseases to which they may happen to be subject. In severe drought or unfavorable winter weather this is apt to prove more disastrous to the stand than if the plants were in the vigorous conditions rendered possible by a soil well filled with humus. It is for this reason that seeding in the spring with a nurse crop has so often failed within recent years. The lack of humus in the ground not only prevents the clover plants from making their best growth but also renders the ground hard and unretentive of moisture, especially when the grain crop is removed. The weakened clover plants are in no condition to withstand the sudden removal of the nurse crop and frequently succumb.

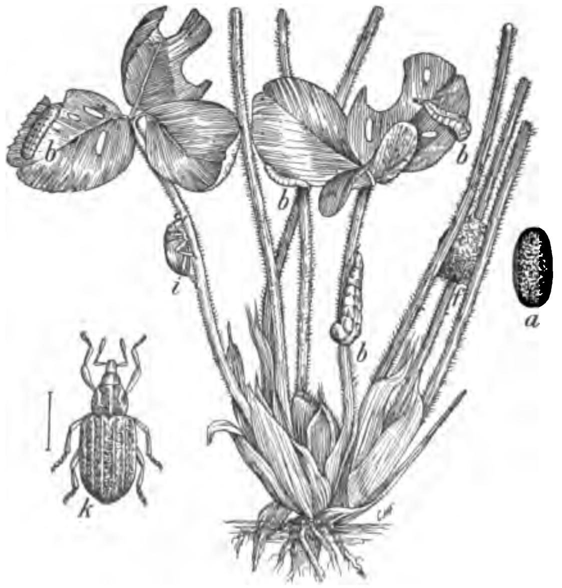

FIG. 22.—The clover-leaf weevil: *a*, Egg; *b*, *b*, *b*, *b*, larvæ feeding; *f*, cocoon; *i*, beetle, side view; *k*, same, back view; (*b*, *f*, *i*, natural size; others more or less enlarged). (Adapted from Riley.)

The methods outlined under "Need of experiments with red clover" (p. 20) will indicate whether or not it is possible to overcome the apparent inability of the soil longer to produce paying stands of red clover. It is probable that there are very few so-called clover-sick sections where clover will not succeed if the ground is well supplied with lime and enriched with suitable manure or humus in some form. This is especially true if the clover is seeded alone, thus avoiding the injurious effect of the nurse crop, especially in regard to shading and

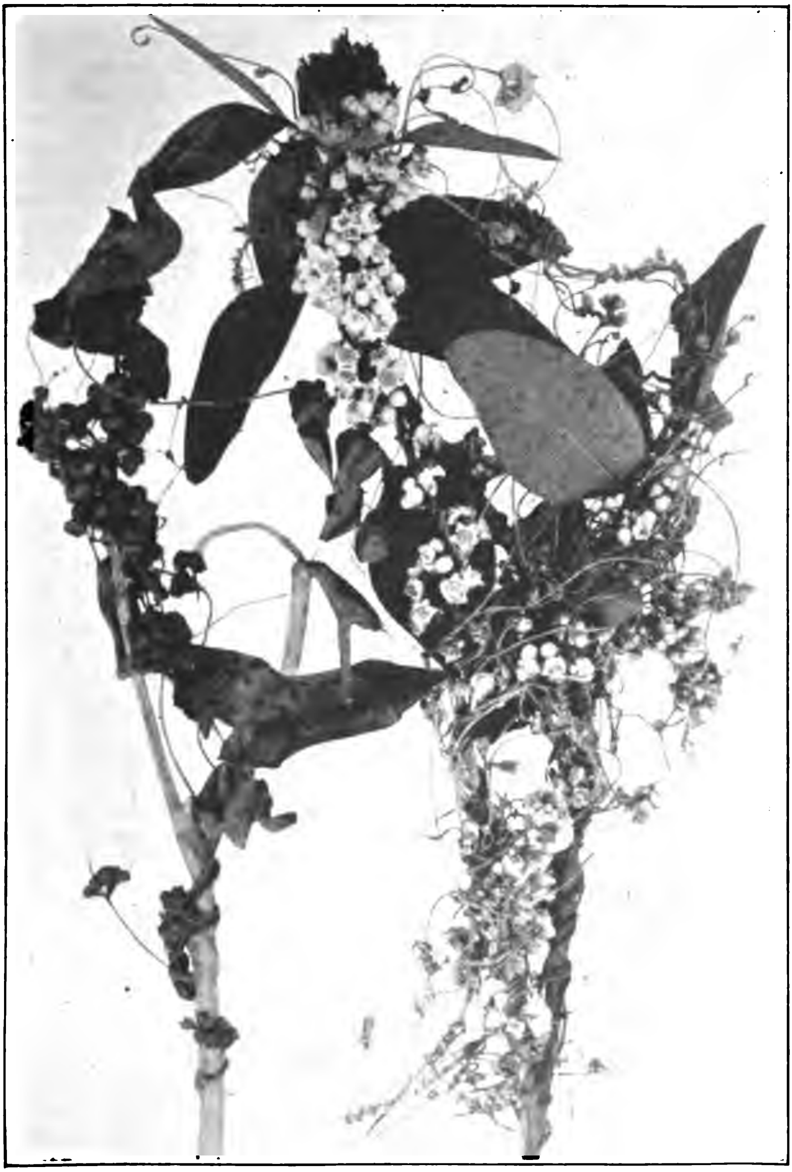

FIG. 23.—Field dodder on stems of red clover. At the right the dodder is shown in flower; at the left, in the mature or seed-producing stage.

the drying out of the soil. It will thus be seen that at least most of the so-called clover-sick lands really only lack one or more of the essential soil constituents to bring them into the proper condition for producing successful stands of clover and other crops.

The failure of clover to produce satisfactory stands should be taken as a warning that something is wrong with the system of farming operations and that it will only be a question of time when other crops will no longer continue to give satisfactory returns. Many of the unproductive farms of the northeastern part of the United States date the beginning of their downfall from the inability of the soil to raise the accustomed crops of clover. This condition is being met with to an increasing extent farther west, and its importance is one that justifies the most serious attention on the part of all interested in the permanent agricultural prosperity of the country. It is probable that with the maintaining of better soil conditions as regards fertilizers—especially humus, phosphoric acid, and lime—in practically all sections the growth of clover will be vigorous enough to withstand the other enemies which have been cited as producing a disastrous effect upon the stands of clover.

RESTORING CLOVER TO ITS PROPER PLACE IN ROTATIONS.

Ultimate failure of the usual method.—Under natural conditions the growing vegetation remaining in place and rotting gradually fills up the soil rather than depletes it, but if crop after crop is removed from the ground much of the valuable plant food is taken away. The loss of humus, among other things, leaves the ground hard and packed. Soils thus depleted do not absorb rains readily and droughts have much greater effect upon them than upon soils under natural conditions. Clover seed sown with the grain crop as in the early days on the surface of the soils thus impoverished usually fails to make satisfactory growth. It is then that special expedients must be adopted in order to retain clover in the farm rotation.

Among the expedients which may be adopted is the increasing of the fertility and humus content of the soil (1) by the application of barnyard manure, (2) by the plowing under of any green-manure crop that will produce sufficiently large growth, or (3) by such extreme measures as the spreading of straw on the land as a means of increasing the humus content. If the soils are inclined to be acid the application of land plaster and lime will often react wonderfully on the vigor of the clover.[1] This fact is illustrated in figure 9. Another means of bringing clover again into the rotation is the seeding of alsike clover instead of using either the ordinary red or the Mammoth clover. Alsike will often grow on soils no longer fit for the successful growth of red clover. The growth of alsike should not ordinarily be kept up permanently, however, as its yield is considerably less than that of the ordinary red clover, but it is valuable as a preliminary crop to be used in connection with the other means of restoring the nitrogen and humus content of the soil and bringing it back to the proper condition for the growth of more valuable strains of clover. Seeding the clover without a nurse crop, thus giving it entire possession of the land, will usually be attended with much better results than where the clover is forced to share the land with a nurse crop.

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[1] See Circular 22, Bureau of Plant Industry, entitled "Farm Methods of Applying Land Plaster," etc., p. 3.

Top-dressing wheat with manure for clover.—Under normal conditions where an abundance of manure is properly applied successful catches of clover are obtained with very little difficulty. Fertilizer experiments with red clover have shown the excellent effect which even an ordinary top-dressing of manure will produce. When the soil is badly run down, manure will probably do the most good applied as a top-dressing on the wheat in which the clover is sown. The experience of farmers who have rather heavily top-dressed the poorer spots on the fields to have them produce the best crop of clover under apparently such unfavorable conditions only goes to show the marked effect of manure in producing a crop of red clover. The field shown in figure 8 indicates the effect of a top-dressing of manure as compared with no application of manure. The introduction of the manure spreader in many sections has solved what was becoming the serious problem of the so-called clover-sick lands.

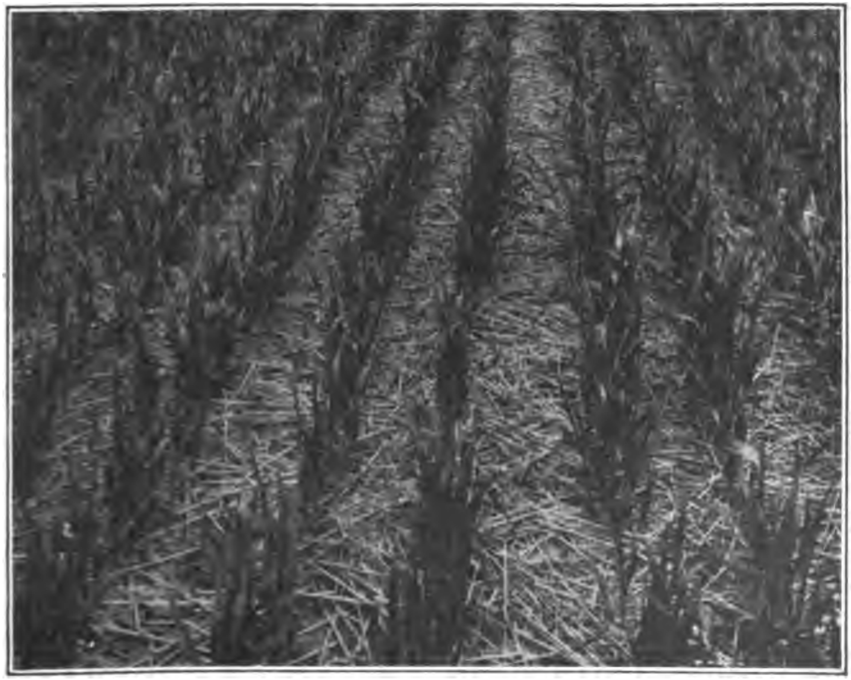

FIG. 24.—View of a wheat field on which straw has been scattered in preparation for clover seeding. The straw is put on soon after the wheat is sown and the clover is seeded the next spring.

Scattering straw on wheat ground for clover.[1]—Along the southern border of the corn-belt States (Illinois, Indiana, and Ohio, especially), on the wheat lands in the hill sections where the ground is becoming deficient in humus and clover seedings very frequently fail, the practice of scattering straw on the wheat in winter and early spring before the seeding of clover germinates is proving to be an important factor in obtaining a successful stand of clover. By this method a catch of clover is practically certain where under ordinary conditions it is usually a failure. In some sections even cornstalks are used in this manner as a mulch. This is an expensive undertaking and is attempted only as a last resort, but it indicates the need of the soil for humus and suggests the need of adding humus by less expensive means. Instances in these same sections have also been observed where red clover is successful only when seeded on ground that has previously been in mulched potatoes, the other fields of the farm being too poor in humus. The apparent effect of the wheat straw is to supply an abundant amount of humus, to conserve the moisture, and to prevent surface packing. (See figs. 24 and 25.)

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[1] For an extended discussion of this method, see Circular 111, Ohio Agricultural Experiment Station, entitled "The Management of Clover in Corn-Belt Rotations," by J. A. Drake.

The tendency has been in the past to assign too little importance to the production of humus in the soil, and it is probable that the difficulty with clover experienced by the farmer in the corn-belt sections is due to the gradual but certain exhaustion of humus.

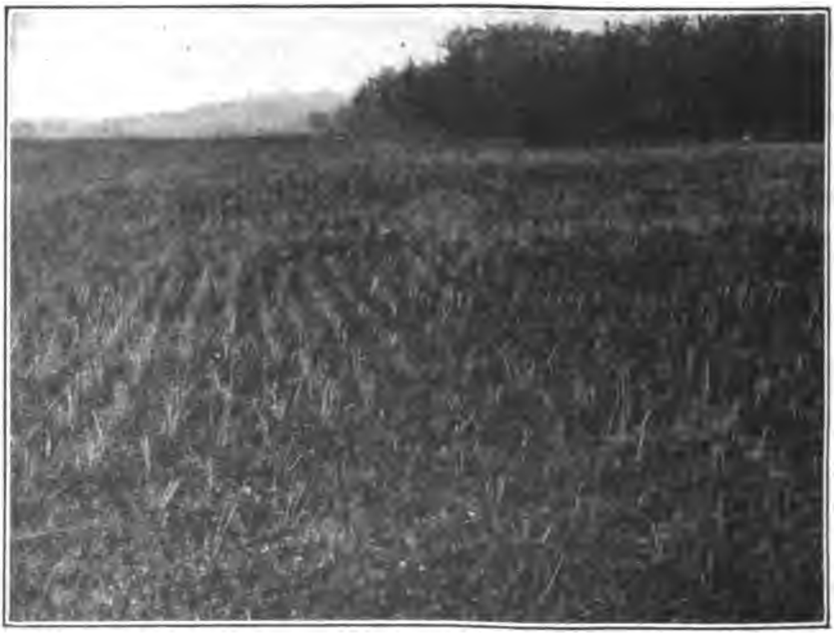

FIG. 25.—View of the field illustrated in figure 24, showing the excellent stand of clover obtained by applying a top-dressing of straw. On some soils clover is likely to prove a failure without this or similar treatment.

RED CLOVER PRODUCTION IN DIFFERENT SECTIONS OF THE UNITED STATES.

The foregoing general consideration of red clover production has dealt mainly with its growth in the clover-belt States. (Fig. 1.) In this region the clover is seeded with spring grain in the northern sections where winter wheat is not grown. It is also often seeded with spring-sown grain in the Ohio Valley States and immediately westward, although it is a common practice to seed in the spring on the wheat fields which were seeded to wheat the autumn preceding.

In the mountain valleys of the Rocky Mountain States spring seeding with spring-seeded grain is the common practice, while in the Columbian basin (eastern Oregon, eastern Washington, and northern Idaho) in sections where the annual rainfall is at least 20 inches clover may be seeded in the spring, but without a nurse crop, as the summers are very dry.

In western Oregon and western Washington red clover is more generally grown than alfalfa. The clover is seeded either in the spring or fall with the grain, except that when the grain is seeded very late in the fall the clover is not seeded until the following spring. Annual applications of about a hundred pounds of land plaster to the acre are usually necessary.

Red clover grows well in the Southern States on rich limestone soils which are in good condition, but needs to be managed somewhat differently from the methods followed in the Northern States. It should be sown in the fall, as soon as possible after the first of September. When sown at that time on well-prepared and finely pulverized soil, the land being rolled to compact the surface soil and prevent it from drying too quickly, the seed seldom fails to germinate and to make sufficient growth to become well established before cold weather. The crab-grass and weeds which come up with it are killed by the first heavy frost, and when the warm days of spring come the clover grows so rapidly that the weeds are kept down. On good soil it will make from 2 to 2½ tons of hay in May with a lighter crop of hay or a good crop of seed in July. In favorable seasons it will make a third cutting, after which it usually begins to fail; the ground may then be plowed for winter oats. If not plowed under the clover will often make a cutting the following May nearly equal to the first cutting of the preceding season. After this most of the plants die and the ground should be plowed for corn or some other late-planted crop. Red clover is undoubtedly one of the best of the clovers for rich soils which are in a good condition, but it is useless to sow it on barren fields or on rough and poorly prepared lands of any kind. It may be expected to grow on any soil which will grow alfalfa successfully. It has not proved satisfactory on either sandy or "white lime" lands.

SUMMARY AND CONCLUSIONS.

The production of clover is the foundation of agriculture in the Eastern and North Central States, as upon its successful growth depends to a large extent the maintenance of the nitrogen content of the soils in the principal crop-producing sections. Clover must not be looked upon as a cure-all for farm troubles. Its roots do add large quantities of the very valuable nitrogen and humus to the soil, but aside from bringing up a limited supply of phosphoric acid and potash from the lower layers of the soil it does not add the other important fertilizer elements to the soil upon which it grows; upon many soils these elements (particularly phosphoric acid) must be added the same as though no clover was being grown upon them. So long as the soil is fairly well supplied with humus and is not too greatly depleted of the ordinary fertilizer elements there is usually no difficulty in obtaining successful stands of clover by the ordinary methods of seeding; but when continued cropping reduces the humus content of the soil to a point below that required for successful clover production it becomes necessary to adopt radical means to restore the ground to its proper condition. It has been repeatedly shown that the failure of the clover in a section is but a prophecy of the early failure of other leading crops in that particular section. The substitution of alsike for ordinary red clover will enable clover to be continued in the rotation on some soils which no longer grow the ordinary red clover. The lack of humus in the soil is the most potent factor in the failure of red clover in these sections, but other factors such as too acid a soil and the presence of fungous diseases or insect enemies, must also be overcome. Liming and proper drainage will overcome the soil acidity. The insects and fungous diseases may be held in check by clipping or cutting at the proper time and by furnishing the proper soil conditions to produce a crop so vigorous that it will succeed in spite of the enemies which prove troublesome to less vigorous stands.

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Issued June 30, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 456

OUR GROSBEAKS AND THEIR VALUE TO AGRICULTURE.

BY

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Assistant, Biological Survey.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., April 21, 1911.

Sir: I have the honor to submit herewith and to recommend for publication as a Farmers' Bulletin a report on the Relations to Agriculture of Our Native Grosbeaks, by W. L. McAtee, assistant in the Biological Survey. Like many other native species the grosbeaks inflict some damage to crops, but the good they do by the destruction of noxious insects far outbalances the harm. The present bulletin aims to make these birds known to the farmer and to explain the nature of their services, so that he may appreciate them at their full worth and protect them.

Respectfully,

Henry W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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OUR GROSBEAKS AND THEIR VALUE TO AGRICULTURE.[1]

INTRODUCTION.

Seven kinds of finches, commonly known as grosbeaks, summer within our boundaries. The majority of these are good friends of the farmer and deserve to be widely known in order that their services may be appreciated. The grosbeaks are easily distinguished from other finches by their stout form, bright plumage, massive bills, and melodious voices. Two of them live mainly in cold or mountainous areas, and, having little to do with farms or with the insects that prey on crops, may be dismissed without further notice. The other five live largely in agricultural regions and secure most of their food about cultivated lands. All of them feed to some extent upon crops, but only one does appreciable harm. On the other hand, all perform invaluable service in destroying certain of our worst insect pests. It is the purpose of this bulletin to make known the exact nature of the services rendered by grosbeaks, to suggest means of reducing or preventing such damage as they do, and to propose methods of protecting them.

FOOD HABITS.

Rose-breasted grosbeak; Potato-bug bird (fig. 2).—The rosebreast has an extensive range, breeding from Kansas and the mountains of Tennessee north to Newfoundland and the Great Slave Lake region. It eats some green peas, and is charged with injuring orchards, both by budding and by eating the fruit. Our investigations lend no support to the latter accusation, and, although the birds eat peas, they invariably consume enough injurious insects to more than offset the damage.

The rosebreast has long been held in high esteem because of its habit of preying upon the Colorado potato beetle, and the name potato-bug bird suggests its important services in this direction.

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[1] For a fuller account of the food habits of the grosbeaks, see Bulletin 32 of the Biological Survey, 1908.

Larvæ, as well as adult beetles, are consumed, and a great many are fed to nestlings. No less than a tenth of the total food of the rose-breasts examined consists of potato beetles—evidence that the bird is one of the most important enemies of the pest. Its services in devouring other exceedingly harmful insects are scarcely less valuable. It vigorously attacks cucumber beetles and many of the scale insects.

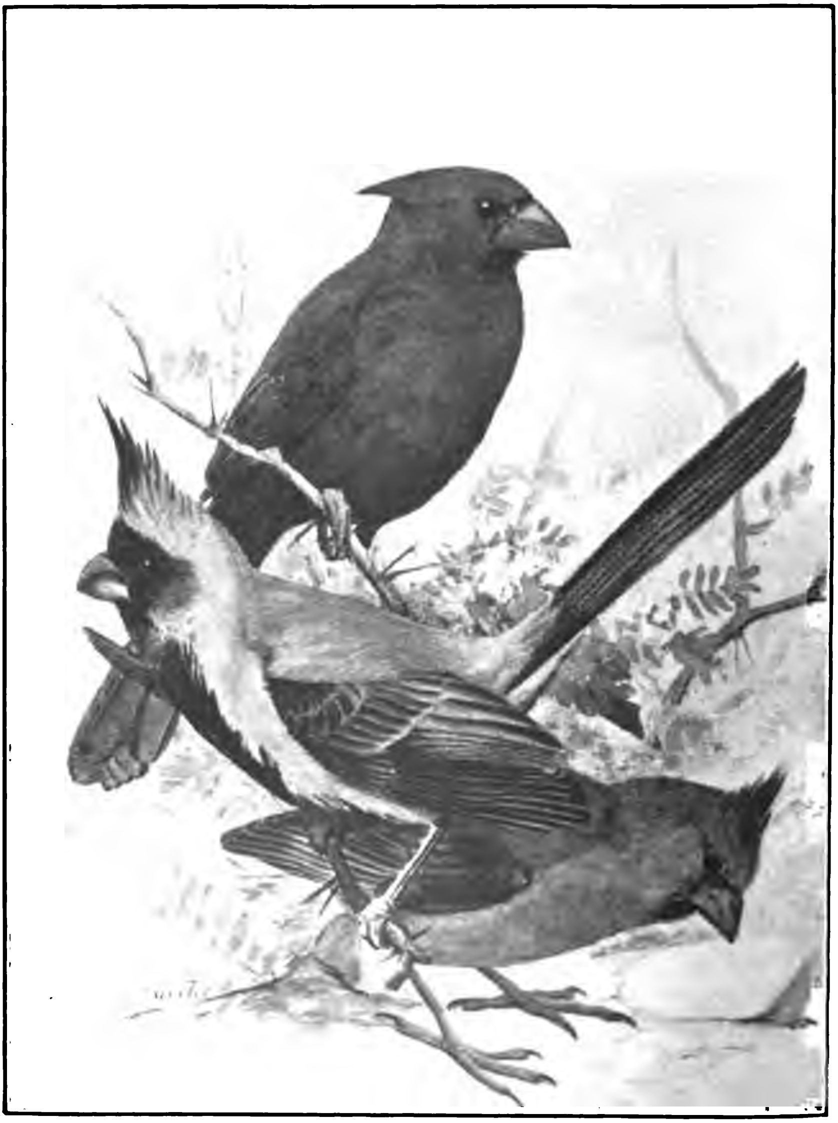

FIG. 1.—Cardinal and gray grosbeaks. [Upper figure, male cardinal; middle figure, male gray grosbeak; lower figure, female cardinal.]

It proved an active enemy of the Rocky Mountain locust during that insect's ruinous invasions, and among the other pests it consumes are the spring and fall cankerworms, orchard and forest tent caterpillars, tussock, gipsy, and brown-tail moths, plum curculio, army worm, and chinch bug. In fact, not one of our birds has a better record. The rosebreast attacks the worst enemies of agriculture, making them its favorite prey, and time after time it has rendered valuable aid in checking their destructive infestations.

Cardinal; Redbird (fig. 1).—Cardinals range from southern Mexico, Lower California, and Arizona, north to Iowa and Ontario, and east to the Atlantic coast. They are permanent residents, spending the summer and winter in the same locality. It has been claimed that they pull sprouting grain, but no evidence of damage to either grain or other crops is afforded by the examination of more than 500 stomachs. On the other hand, the evidence is ample that they do much good. The redbird is known to feed on the Rocky Mountain locust, periodical cicada, and Colorado potato beetle. It is a great enemy also to the rose chafer, cotton worm, plum or cherry scale, and other scale insects, and attacks many other important insect pests, including the zebra caterpillar of the cabbage, the cucumber beetles, billbugs, locust flea-beetle, corn-ear worm, cotton cutworm, southern figeater, codling moth, and boll weevil. In addition, it consumes a great many seeds of injurious weeds. Thus its food habits entitle the bird to our esteem, as its brilliant coat and spirited song compel our admiration.

Black-headed grosbeak; Western grosbeak (fig. 2).—The black-headed grosbeak ranges from southern Mexico to British Columbia, North Dakota, and Nebraska. It fills the same place in the West that the rosebreast does in the East, and economically is fully as important. In parts of its range it is destructive to early fruit and attacks also green peas and beans. However, since by proper precautions such losses may be minimized or altogether prevented, they should not be given too much weight in estimating the value of the bird. Instead of being regarded as an enemy by western orchardists, the blackhead should be esteemed as a friend, since it is a foe to the worst pests of horticulture—the scale insects—which compose a fourth of its food. The black olive scale alone constitutes a fifth of the bird's subsistence, and the frosted scale and apricot scale, or European fruit Lecanium, also are destroyed. In May considerable numbers of cankerworms and codling moths are eaten, and almost a sixth of the bird's seasonal food consists of flower beetles, which do incalculable damage to cultivated flowers and to ripe fruit. For each quart of fruit consumed by the black-headed grosbeak it destroys in actual bulk more than one and a half quarts of black olive scales, one quart of flower beetles, besides a generous quantity of codling moth pupæ and cankerworms. So effectively does it fight these pests that the necessity for its preservation is obvious, while most of its injury to fruit is preventable.

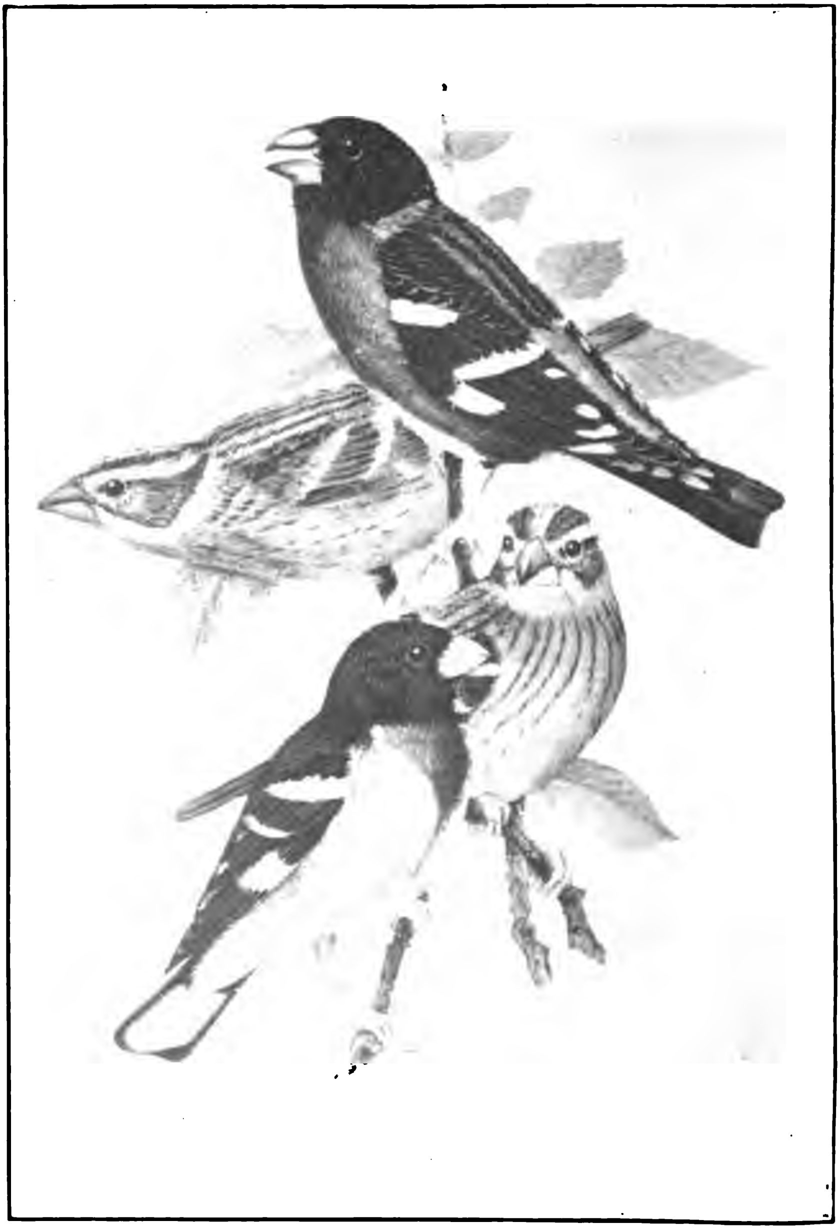

FIG. 2.—Black-headed and rose-breasted grosbeaks. [Upper figures, black-headed grosbeaks, male and female; lower figures, rose-breasted grosbeaks, male and female.]

Blue grosbeak; Blue pop (fig. 3).—This small but beautiful bird, breeds over the southern two-thirds of the United States. It is rather rare in the northeastern part of this range, but is common locally in the southern and western parts. Blue grosbeaks do no damage during the nesting period, and, in fact, are of great value to any farm they choose for a home, since they eat large numbers of injurious insects and feed their young exclusively upon them. In certain localities, however, after the breeding season, blue grosbeaks collect in flocks, move into grainfields, particularly those of oats and rice, and sometimes do considerable harm. Despite such depredations, the loss

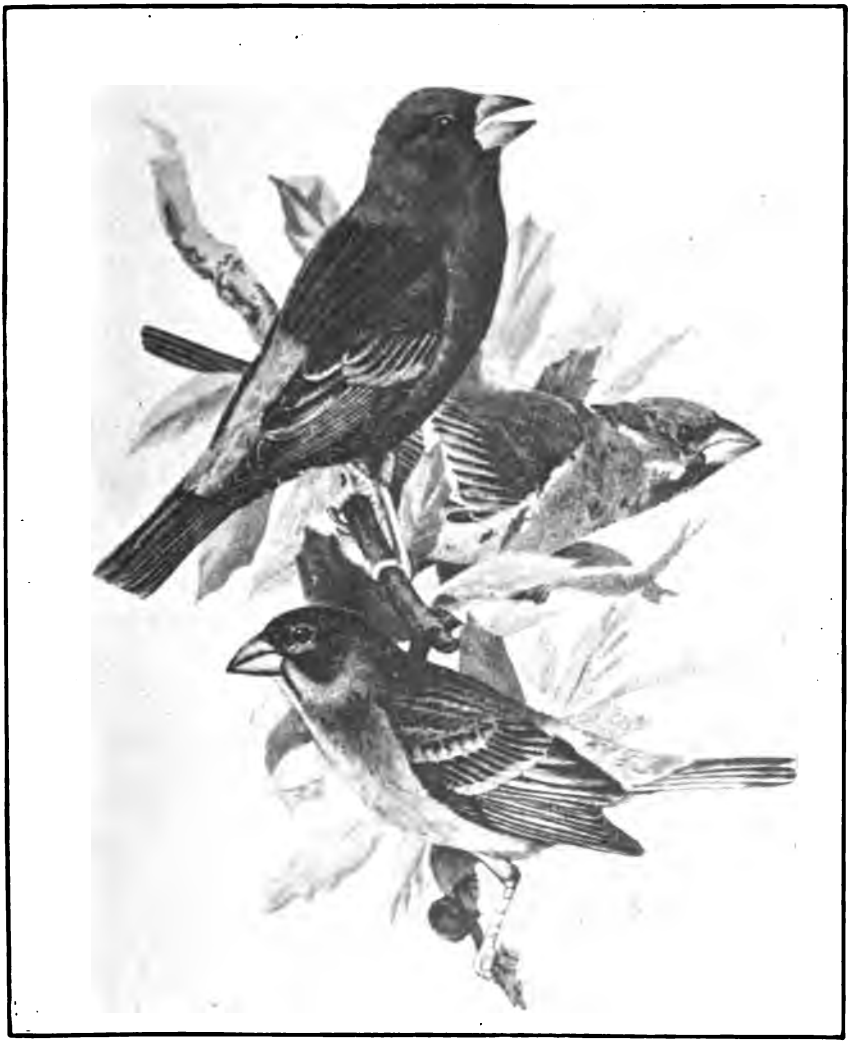

FIG. 3.—Blue grosbeaks. [Upper figure, adult male; midle figure, immature male; lower figure, female.]

of cereals is repaid many fold, since the birds consume almost five times as much insect food as grain. Moreover some of the insects they devour are especially destructive, such as weevils. More than a fourth of the seasonal food is composed of grasshoppers, including the lesser migratory locust. A tenth of the subsistence is made up of purslane caterpillars and cotton cutworms, enemies of sugar beets and cotton. Because of its effective warfare on these pests, the blue grosbeak is an efficient ally of the farmer and deserves to be protected.

Gray grosbeak; Parrotbill.—This handsome grosbeak enters the United States only in Texas, Arizona, and New Mexico, and comes in contact with cultivated crops less than the four related species. Like the blue grosbeak it is more fond of caterpillars and grasshoppers than of other insects. Weevils are next in order of preference. The parrotbill ranges over much of the cotton belt of Texas and feeds upon two important cotton pests, one of which—the boll weevil—is one of our most destructive insects. Cotton worms also are highly relished, as many as 18 having been found in a single stomach. In August and September seven-tenths of the gray grosbeak's food is weed seed, five-tenths consisting exclusively of the seeds of two of the most important weeds of the South, namely, foxtail and bur grass. So far as known, the gray grosbeak eats practically no beneficial insect and damages no crop. This, in addition to the fact that it feeds upon noxious weed and insect pests, entitles it to complete protection.

MEANS OF PREVENTING DAMAGE TO CROPS BY GROSBEAKS.

Grain.—Three of the grosbeaks, the rose-breasted, black-headed, and the cardinal, are charged with pulling more or less seed grain. This fault, however, is not very serious, since it is well known that repellant mixtures applied to grain before sowing protect it completely. Although the fact is not so well known, grain so treated can be sown by machine, provided the following directions are observed:

> Put one-fourth to one-half bushel of corn [or other grain] in a half-barrel tub; pour on a pailful of hot water or as much as is necessary to well cover the corn; dip a stick in gas tar and stir this briskly in the corn; repeat until the corn is entirely black; pour off onto burlap (bran sacks are excellent); spread in the sun and stir two or three times during the day. If this work is done in the morning and the day is sunny, the corn will be ready for the planter the next day without any other care. The hot water softens the tar, so that only just enough will adhere to the corn, and the corn is completely glazed by the sun.

Ethan Brooks, who recommends this method, considers it by far the quickest way of tarring corn, and states that for years he has planted with a machine corn treated in this way.[1]

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[1] Ann. Rept. Mass. State Bd. Agric., p. 294, 1896.

In cases where grosbeaks or other small birds are the only ones that injure seed grain, it is probable that the above precaution may be safely omitted. Drilled grain, especially if planted by a machine which packs soil over the seed, is safe from their attacks. If the birds simply nip off the leaf, no particular harm is done. Indeed in some cases the crop is benefited by the stooling this process stimulates.

Standing grain may be insured against the attacks of small birds by planting a few rows of millet on the edges of the field. Millet is a prime favorite with all grain-eating birds and should be sown so as to ripen at the time the grain is exposed to damage.

Grosbeaks sometimes steal corn from cribs, but the remedy is obvious. A lining of small-meshed wire netting, besides protecting the contents of the crib from birds, does greater service by keeping out mice and rats.

Peas.—The rose-breasted and black-headed grosbeaks eat peas, and the latter eats green beans also. Experience shows that a scarecrow suffices to ward off the rosebreast, but the blackhead appears less easily intimidated. In localities where the birds are abundant bird netting used as a cover is effective and is advised for small patches.

Fruit.—Only one grosbeak, the black-headed, does noteworthy damage to fruit. Where the trees are few, the use of bird netting is recommended. This method was devised and used successfully by Prof. J. Troop, of the Indiana Experiment Station, to protect cherries. The netting cost 4 cents per square yard, and 75 yards were required to cover trees 10 feet high. The expense of the netting, which is good for 10 years, was defrayed from the sale of the first season's fruit. This method is undoubtedly of great value for a small number of trees. In large orchards the best plan is to plant among the fruit trees or on the edges of the orchard a number of wild fruit trees as decoys. The best for the purpose are elder (especially in the West), mulberry, juneberry or serviceberry, and wild or seedling cherries. The Biological Survey is prepared to make specific recommendations for planting trees to protect fruit in any part of the country.

HOW TO ATTRACT AND PROTECT GROSBEAKS.

Planting wild fruit is important for the purpose of attracting birds. Besides the fruits above mentioned, the following are valuable: Dogwoods, hollies, juniper, bayberry, Virginia creeper, blueberries, blackberries, and wild grapes. Not all the thickets on a farm should be removed, since they serve to harbor birds, to protect them from enemies, and to furnish nesting sites. Where thickets are lacking, the growth of artificial ones should be encouraged, for they are very attractive to grosbeaks, particularly to the cardinal.

A permanent drinking and bathing place on the farm and in the garden is to be numbered among the most potent attractions for birds, and with a little ingenuity one can be prepared in almost any locality. Winter feeding serves to attract the cardinal, which relishes corn, sunflower, and other seed, and takes kindly even to table scraps. If particular premises prove congenial as a winter home, the bird is likely to prefer them in summer.

No efforts to attract grosbeaks will succeed, however, unless protection is assured. Grosbeaks are already protected by law in practically every State, but, since the machinery for the enforcement of the laws is often ineffective, statutory protection must be supplemented by individual action, particularly under trespass laws. Such action has long been taken in behalf of game birds, and the wise landholder will take equal precautions to preserve the smaller insectivorous species which he is so fortunate as to have as tenants. Shooting and nest robbing must, of course, be barred. Squirrels, when allowed to become too numerous, destroy many eggs and young. But in the settled districts the worst enemy of birds is the prowling cat. In certain islands, cats have completely exterminated many birds, including almost every kind nesting on or near the ground, and everywhere they levy a heavy toll upon small insectivorous species. Unquestionably, if the number of birds is to be materially increased, measures must be taken to dispose of roving cats. Grosbeaks are usually able to defend themselves and their nests against the English sparrow, but for the sake of other small birds the numbers of this foreign pest should be materially reduced.

CONCLUSION.

Present investigations prove that the services of grosbeaks in destroying insect pests are invaluable. Each kind pays special attention to certain pests which if unchecked would cause enormous losses. Few of our birds are to be credited with more good and with fewer evil deeds than the grosbeaks, and none more clearly deserve protection by the practical farmer.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

1366 Issued July 10, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 457.

Experiment Station Work,

LXIV.

Compiled from the Publications of the Agricultural Experiment Stations.

LOW-GRADE FERTILIZERS.
JAPANESE CANE FOR FORAGE.
FIGHTING THE BOLL WEEVIL.
HASTENING MATURITY OF COTTON WITH FERTILIZERS
THE SCUPPERNONG.
EARLY SPRING LAMBS.
PRODUCTION OF SANITARY MILK.
LACTO: A FROZEN DAIRY PRODUCT.
A REINFORCED BRICK SILO.

MAY, 1911.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

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[1] Director.
[2] Special agent in charge.
[3] Acting Director.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[1]

LOW-GRADE FERTILIZERS ARE EXPENSIVE.[2]

The old adage "never buy a thing simply because it is cheap; it will be dear to you in the end" applies with special force in the purchase of fertilizers. No one thing has been more clearly demonstrated by the work of the experiment stations than that it does not pay to buy low-priced, low-grade fertilizers. The low-grade fertilizers, though cheaper as measured by price per ton, are more expensive when measured by the actual amount and quality of plant food which they contain and by the cost of handling. B. E. Rose, from a comparison of the composition and cost of fertilizers on sale in Florida, shows that "the high-grade fertilizers for but little more than a third advance in price over the cost of the low-class goods furnish two-thirds more plant food and five-sixths more commercial value." Classifying the 127 brands of fertilizers examined by him during one year, Prof. Rose found the following results:

Relative composition, selling price, and valuation of low-grade, medium, and high-grade fertilizers.

Class.	Nitrogen.	Available phosphoric acid.	Potash.	Total plant food.	Average selling price.	Average station valuation.	Excess of selling price over valuation.
	Per cent.	*Per cent.*	*Per cent.*	*Lbs.*			
Low grade	1.13	8.28	2.50	11.9	$24.50	$16.85	$7.65
Medium grade	2.32	8.72	3.66	14.4	30.00	24.84	5.16
High grade	4.00	7.00	10.00	21.0	36.50	32.70	3.80

This table shows that with the low-grade fertilizers the selling price was 45 per cent greater than the valuation, with medium-grade fertilizers 20 per cent, and with high-grade fertilizers 11 per cent. The same facts are shown graphically in figure 1.

An examination of fertilizers sold in Vermont in 1910 showed that—

> The medium-grade goods for one-ninth in advance in price over the cost of the low-grade brands offered one-fifth more plant food and two-fifths more commercial value.

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[1] A progress record of experimental inquiries published without assumption of responsibility by the department for the correctness of the facts and conclusions reported by the stations.

[2] Compiled from Indiana Sta. Bul. 148; Massachusetts Sta. Bul. 135; Mississippi Sta. Bul. 142; Missouri Sta. Bul. 91; New Hampshire Sta. Circ. 12; New York State Sta. Bul. 230; Vermont Sta. Bul. 154; Univ. Rec. [Florida], 5 (1910), No. 3, p. 97; Maryland Agr. Col. Quart., 1911, No. 51.

The high-grade fertilizers for three-sevenths advance in price over the cost of the low-class goods furnished nearly three-fifths more plant food and almost double the commercial value. * * *

Some Vermont buyers paid 44½ cents for a pound of nitrogen which they might have bought for 26½ cents laid down at their doors in mixed fertilizers. They paid under similar circumstances 9½ cents a pound instead of 5¾ cents for phosphoric acid and 9½ cents for potash instead of 5½ cents.

From an examination of fertilizers sold in Massachusetts in 1910 H. D. Haskins shows "that nitrogen cost 8.96 cents, available phosphoric acid about 2 cents, and potash 1.9 cents per pound more in the average low-grade fertilizer than in the average high-grade goods."

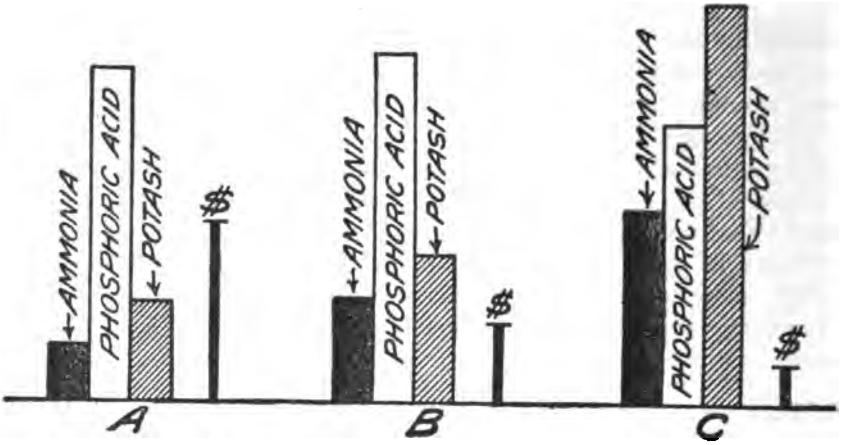

FIG. 1.—Diagram showing relative composition and value o. fertilizers: *A*, Low grade; *B*, medium grade; *C*, high grade.

Noting the fact that over half of the fertilizers were medium or low grade, Mr. Haskins says:

> It is evident that too many purchasers select a fertilizer for its low cost and without much regard to the plant food which they are getting. The object in buying a fertilizer should be to get the largest amount of plant food in the proper form and proportion for the least money. The high-grade goods approach as near this ideal as is possible in case of factory mixed fertilizers. It costs just as much to freight, cart, and handle the low-grade fertilizers as it does the high grade. Nitrogen and potash in low-grade fertilizers cost from a third to a half more than if obtained from high-grade goods. The farmer can not afford to buy low-grade fertilizers.

A bulletin of the Missouri Station calls attention to the fact that there is a great demand in that State for cheap fertilizers which is supplied by a low-grade fertilizer containing about 0.82 per cent of nitrogen, 7 per cent of available phosphoric acid, and 1 per cent of potash, and selling for $19 per ton. The station valuation for this fertilizer is $12.88. It is shown that a fertilizer supplying the same amounts of plant food in form of high-grade materials could be prepared from 125 pounds of dried blood, 110 pounds of sodium nitrate or 200 pounds of tankage, 1,000 pounds of 14 per cent acid phosphate or 875 pounds of 16 per cent acid phosphate, and 40 pounds of high-grade sulphate of potash. By using such a mixture handling and freight on from 760 to 975 pounds of useless "filler" for each ton of fertilizer would be saved. Moreover, this saving of freight and handling is not the only advantage of eliminating "filler," for in these cheap fertilizers garbage tankage and muck or peat "filler" are used to a considerable extent to supply the bulk and at the same time to furnish a considerable portion of the nitrogen, the most expensive ingredient of the fertilizer, and it is a well-known fact that the nitrogen in these materials is much less available than in high-grade materials.

> Many farmers say they can not afford to spend more than $1.50 per acre for fertilizer on their corn or wheat, which means they are using about 150 pounds per acre of the low-grade fertilizer above mentioned. A fertilizer containing 2½ per cent nitrogen, 24 per cent phosphoric acid from bone, and 4 per cent potash can be bought for about $30 per ton. * * *
>
> One ton of such a fertilizer costing $30 will contain over 250 pounds more of total plant food than 2 tons of low-grade fertilizer, costing $40 for the 2 tons. The 1 ton of high-grade fertilizer contains about $6 worth of plant food more than the 2 tons of cheap fertilizer, making a saving to the farmer of about $16 ,with only one-half as much to haul from the station. If he uses one-half as much per acre of the high-grade fertilizer, he is using more plant food with an actual saving of at least 60 cents per acre.

A bulletin of the Mississippi Station says:

> The purchase of the so-called cheap or low-grade fertilizers is certainly never advisable. The cheapness of these mixtures is only apparent. It is not the price per ton of the fertilizer, but the price per pound of the plant food in it which should be subjected to inquiry by the merchant or farmer who is ready to buy.
>
> A low-grade fertilizer can be sold by the retailer at a low price per ton, but no saving is effected when the price per pound of its valuable ingredients is considered.

The Indiana Station has repeatedly urged farmers to buy fertilizers on the basis of unit of available plant food desired and not on price per ton, and has pointed out "the folly of purchasing low-grade fertilizers at an increased cost per unit of plant food and paying freight on a large amount of filler which is without value."

H. B. McDonnell, of the Maryland Agricultural College, says, "avoid the 'cheap' low-grade fertilizers if you would avoid filler. * * * The cheapest filler is the soil in the field and the cheapest mixing machine is the harrow."

It thus appears plain that not only are low-grade fertilizers more expensive as regards first cost of plant food, but they are more costly to handle per unit of plant food supplied than the high-grade fertilizers on account of the larger amount of worthless filler which they contain. If low-grade fertilizers are to be used, it is much more economical to buy the unmixed materials, as suggested by the Missouri Station.

JAPANESE CANE FOR FORAGE.[1]

Natural grasses will supply forage for live stock in the South except for a short period during the winter months. Japanese cane will meet the need for good pasture from the middle of November to March. It is thus very important because it will supply a large amount of roughage at the season when natural pasturage is limited.

J. M. Scott, of the Florida Station, says that there were in that State 412,820 head of cattle January 1, 1900, and 807,000 January 1, 1910. He estimates that "if the number of cattle should increase as rapidly in the next 10 years as in the last 10 years, we shall own one million and a half head in 1920." A factor limiting such an increase is the ability of the State to supply sufficient forage to feed such a number of animals. If we stop to consider that on January 1, 1910, there were also 98,000 sheep and 456,000 hogs in Florida, we will realize the enormous quantities of forage required. "The needed extra supply of forage can easily be obtained by the growing of Japanese cane. There is no other crop that we can grow that will produce such a large yield of forage at so small a cost."

Japanese cane was introduced through the Louisiana Sugar Experiment Station for sugar and sirup production, but is of practical value mainly as a forage crop. It will yield from 150 to 500 gallons of sirup per acre, but is not grown for this purpose because of difficulty in stripping and grinding. It may be used as silage for winter pasture or stored as dry forage. It is best adapted to the climatic and soil conditions in Florida and the southern portions of Georgia, Alabama, Mississippi, Louisiana, and Texas, but will do well in any section in which the velvet bean will mature seed. This includes the territory within 200 to 250 miles of the northern coast of the Gulf of Mexico.

A variety of soils will grow Japanese cane reasonably well, but every farmer in Florida should grow a few acres whether he has the class of soil best suited to it or not. The same statement will apply to other regions to which it is adapted. Although good hammock land will doubtless produce the heaviest yields, high pine lands properly fertilized will give good returns. On swampy muck a good growth may be expected, but the yield will be greatly increased by an application of ground limestone or burnt lime. The amount which should be added will range from 2,000 to 6,000 pounds of ground limestone or from 1,000 to 3,000 pounds of air-slaked lime per acre. The proper amount of lime to apply will vary with the amount of acid in the soil. An application of 2,000 pounds of ground limestone per acre to high pine land on the Florida Station farm apparently increased the yield more than 10 tons in 1909.

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[1] Compiled from Florida Sta. Bul. 105.

When pastured by cattle little of the cane is wasted. The animals first consume the blades and upper tender joints, then eat from the upper portion of the stalk until only the stubble remains. Pasturing after March 1 by any animals is likely to injure the stand, as the new growth is cropped and the plants may be killed.

Silage made from Japanese cane is relished by cattle and has proved about one-third lower in cost than sorghum or corn silage. It has proved a satisfactory feed for the dairy herd at the Florida Experiment Station and is recommended as "one of the cheapest and most economical crops that the Florida farmer can grow for silage." The cost of cane silage should not exceed $1.75 or $2 per ton.

For dry-forage purposes the crop is easily cured and the storage loss is small. After six months' storage at the experiment station there was practically no loss, and the cane, when run through a feed cutter, was relished by cattle, horses, and mules. If there is no room for storage in the barn it will be profitable to build a temporary inexpensive shed to keep off the rain. The butts of the canes should be placed on the ground in order that they may absorb moisture from the soil. This will prevent them from becoming as dry as they otherwise would.

As Japanese cane is a perennial, it will continue to furnish forage for many years from one planting, if properly handled. It is planted by cutting the canes into pieces or by dividing the stools. The cuttings furnish the cheapest seed. The buds will stand but little frost without injury, so the seed canes should be cut and banked before there is danger from the first fall frost. When banked the canes must not only be covered sufficiently to protect them against frost, but must be furnished proper moisture conditions. If standing water should be present the canes rot, but if the beds become too dry a large amount of the seed will be lost through dry rot. It is a good plan to make several small beds rather than a single large one.

The work and expense of banking seed cane are often saved by planting in the fall immediately after the selection and harvesting of the seed. In the northern and western portions of the State there is danger that fall planting will result in an unsatisfactory stand. In these regions the expense of banking will be repaid by the assurance that only good cane will be planted in the spring. Fall planting between November 10 and 20 is confined to central and southern Florida; north of this region spring planting during the month of March will prove more satisfactory.

If the rows are 8 feet apart about 3,000 whole canes will be required to plant an acre. Only healthy and well-matured canes should be used, as it is nearly impossible to remedy a defective stand. New canes planted in missing hills make little or no growth, because the extensive root systems of well-established canes crowd them out. It costs less to cultivate and keep down the weeds on an acre that will produce 20 tons of cane than on one that will yield but half that weight. The canes should be cut in pieces having 3 or 4 eyes each and dropped in a double line. Some farmers drop 12 to 18 inches apart in a single line. This reduces the amount required to plant an acre to 1,500 or 2,000 canes, but gives a thin stand and a small yield of forage.

The seed bed should be very carefully prepared, because the crop occupies the field a number of years without further seed-bed preparation. The ground should be plowed to a depth of 6 inches and all vegetable growth turned under. It should then be harrowed at once, and the harrowing repeated if necessary to reduce the surface to good tilth. The rows may be laid off with a marker made of 2 by 6 inch lumber if desired. The disk cultivator is the most satisfactory implement for opening the furrow, as well as for covering the canes. The disks should be set close together in throwing out rows and run quite deep. In covering, the disks should be set as far apart as possible in order to avoid catching the canes and throwing them out on the top of the bed. The surface should be left level rather than in ridges. The cost of planting is reduced by 20 to 40 per cent if the disk cultivator is used instead of other implements.

The large root system of this crop makes it a gross feeder requiring a liberal amount of fertilizer. On the experiment station farm good results have been obtained from the application of 2,000 pounds of ground limestone per acre and from 400 to 600 pounds of a mixture containing 3 per cent ammonia, 6 per cent phosphoric acid, and 7 per cent potash. The ammonia may be furnished by dried blood or sulphate of ammonia, and the source of the potash likewise makes no material difference. Because of the long growing season of the crop, half the fertilizer should be applied in the latter part of April and the remainder in the early part of August. This will prevent so much being lost by leaching during the rainy season and insure the plant some food during the latter part of the season. Since a new root system is formed every year, the fertilizer need not be applied early. The feeding roots do not start until the tops have made a considerable growth, and the plants use the stored-up plant food in the old stubs of the rattoons during the early period of growth.

The cultivation of Japanese cane is similar to that of corn and cotton. The seed bed should be even more carefully and deeply prepared, because the crop will probably occupy the same field for a number of years without further plowing. After the first year the ground should be thoroughly stirred 3 or 4 inches deep in the early spring. A disk harrow or a 2-horse cultivator driven between the rows will do the work very well without injuring the roots, as the new growth has not yet been made. A second shallower cultivation should immediately follow the application of fertilizer, and each succeeding cultivation should be shallower than the preceding one to avoid root pruning.

Harvesting should not be done too early. The chief value of the crop lies in its high sugar content, and all saccharine forage crops must reach a certain stage of maturity in order to furnish feed of the best quality. Sugar formation does not go on during rapid plant growth, but only when the cool weather of fall has set in. Cane silage will keep better and have a higher feeding value if made from mature cane. Care should, of course, be taken to prevent injury by frosts, but if fed soon after a frost injury the loss will be slight. The canes are too heavy to be successfully cut with a mowing machine, and after two years' growth the rows spread too widely for successful work with the corn harvester. As yet the most satisfactory instruments for cutting are the machete corn knife and the hoe.

The rows of Japanese cane may be planted 8 feet apart and velvet beans planted 2 or 3 feet apart in the row between them. Both cane and beans should be given good cultivation until long runners prevent further work. The beans should be planted early in the season to prevent the cane from completely smothering them. As the cane is rich in carbohydrates, which include its sugar and fiber, it is well to mix it with high protein feeds. For this purpose velvet beans, cottonseed meal, soy beans, cowpeas, oil meal, alfalfa, or clover may be used if available. Because of the bulky nature of the Japanese cane, the more concentrated foods are especially valuable.

After conducting feeding experiments the Florida Station recommends these rations: (1) 12 pounds of Japanese cane, 10 pounds of velvet beans in the pod, and 2 pounds of cottonseed meal, and (2) 10 pounds each of Japanese cane and cowpea hay, and 8 or 10 pounds of velvet beans in the pod.

FIGHTING THE BOLL WEEVIL BY CLEAN FARMING METHODS.[1]

The Department of Agriculture has spent more than a million dollars in studying and fighting the boll weevil, and the cotton States have added to this sum until it greatly exceeds this figure.

Any effective method of combating the boll weevil must be based on accurate knowledge of its life history and habits. It will feed or breed only on the cotton plant. Clean farming methods attack the weevil by removing its food, prolonging the period of starvation, and destroying the material in which it spends the winter. It has been found advisable to remove stalks and carefully screen in any seed houses which may be in or near cotton fields. Moss on forest trees may shelter vast numbers of weevils during the winter.

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[1] Compiled from Alabama College Sta. Bul. 146; Circs. 5, 6, and 7; Louisiana Crop Pest Com. Circs. 3, 15, 28, and 31. The life history of the boll weevil and methods of avoiding its ravages are fully dealt with in the following publications: Alabama College Sta. Bul. 129; Mississippi Sta. Bul. 139, Circ. 17; Texas Sta. Bul. 74, Circs. 4 and 8; U. S. Dept Agr., Farmers' Buls. 130, 163, 189, 209, 211, 216, 314, and 344; Bur. Ent. Bul. 51, and Circ. 122; Louisiana Crop Pest Com. Circs. 5, 8, 9, 16, 22, 23, 24, 25, 33.

The most important step, however, is the destruction of the cotton plants by October 10, or as soon after that date as possible. It is readily seen that if its only food is removed from three to five weeks before the first killing frost causes it to go into winter quarters, the number of weevils present during the following spring and summer will be greatly reduced. This measure is especially important along the line of advance of the weevil in territory not yet infested. After making long flights late in the season, the presence of growing cotton gives the weevil a good opportunity to feed before going into winter quarters. If the plants have been destroyed early, however, the long flight, followed by starvation, greatly decreases the probability of the weevils appearing the following season in this new territory.

The Louisiana State Crop Pest Commission found that when cotton plants were destroyed before October 15, only 3 per cent of the weevils survive. The necessity for prompt and early destruction of the plants is indicated by the survival of 15 per cent of the weevils where plants remained until the period between October 15 and 27; when plants were destroyed between November 1 and 25 about 22 per cent of the weevils survived; and when the plants were destroyed between November 25 and December 7, 28 per cent of the weevils lived through the winter. Allowing the plants to stand until Christmas allowed 43 per cent of the weevils to survive and attack the next cotton crop. Starvation of the weevil before it entered winter quarters "was more effective in causing death than cold or wet weather during the winter." If the cotton plants are not removed the weevil is not deprived of food for more than about 94 days. If they are destroyed October 10, the average weevil must starve unless it can go 180 days without food. The average time that weevils remained in winter quarters was 159 days. The fact that one weevil lived 255 days, or 8½ months, without food indicates that even the possible 6 months' starvation does not entirely eradicate the weevil, but it prepares the way for much more effective use of other cultural methods and spraying. The length of time between coming out of winter quarters and the death of the weevil has an important application to the time of spraying or other use of poisons. The average weevil lived about 11 days, but in one case this period reached 44 days from winter quarters.

If rains occur after the maturity of the crop many small bolls may be formed. This condition favors the rapid increase of the weevils until frost destroys the cotton. These late-developed weevils are most likely to survive the winter. They do not enter winter quarters exhausted by long flights, starvation, or the other activities of older weevils.

Cotton stalks may be destroyed or removed by (1) uprooting, piling, and burning; (2) by cutting with a stalk chopper, plowing under deeply, and disking the field after plowing; or (3) by turning in enough animals to consume all the green cotton in a few days. The first method is the most effective as the second allows some weevils to escape to the surface unless very thoroughly done. Grazing is possible only in exceptional cases. After the burning method "the cheapest, most effective and preferred plan is to use what is known as the V-shaped cotton-stalk cutter."[1] Stalks not completely severed in cutting should be pulled or chopped to prevent their remaining green and supplying food for weevils. The windrowed stalks may be piled with a pea-vine rake or otherwise and burned after a week or 10 days' drying, crude oil being used if necessary. They should be placed in position to burn while still green, so that the weevils may be concentrated under the rows or piles and destroyed by the fire. Stalks may be plowed out but this is less effective and requires more work.

In addition to destroying the cotton plants on which weevils feed, all kinds of rubbish along ditches, fences, terraces, turn rows and field borders should be destroyed to remove winter shelter.

Perhaps the most convincing proof of the wisdom of the early fall destruction of cotton plants is shown by the actual field results observed in two instances. On November 13, 1907, a severe frost completely destroyed the squares, green bolls, and foliage on the cotton plants in the northern parishes of Louisiana. The following spring the boll weevil was so rare that the newspapers reported that it had entirely disappeared. Farther south where the frost was less severe more weevils survived. A steady increase in the number of surviving weevils was noted from north to south.

During 1906 and 1907 the Bureau of Entomology of this Department conducted a field experiment in Calhoun County, Tex. Cotton plants on 400 acres were uprooted and burned during the first 10 days of October, 1906. No other cotton was grown within 30 miles. 'Up to May 1, 1907, but 1 weevil was found in the 400-acre area at Olivia, while in the check fields, 30 miles away, where the stalks had not been destroyed the previous fall, the weevils were so numerous that practically every square was being destroyed by May 1." In August, 1907, there was an average of 10 bolls per plant left on the Calhoun County fields near Olivia, but only 3 bolls per plant remained where cotton had not been destroyed the previous fall. At Olivia an average of 615 pounds of seed cotton per acre was secured as compared with 225 pounds in the fields 30 miles away, where the cotton was not destroyed the fall before. At 10 cents per pound for lint and $12 a ton for seed this difference in yield paid $14.56 per acre or about 29 times as much as it had cost to clear the fields of green cotton the fall before.

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[1] For description see the succeeding number of this series of bulletins.

HASTENING MATURITY OF COTTON WITH FERTILIZERS.[1]

In order to successfully combat the boll weevil much attention has been given to the development of early ripening varieties of cotton. Recent experiments at the North Carolina Experiment Station, reported by C. B. Williams, show the important extent to which early ripening may be promoted by judicious use of fertilizers.

In a large number of tests on a wide variety of soils it was found that the use of fertilizers in all cases hastened maturity. About 50 per cent more cotton was open at the first two pickings on the fertilized plats than on those which had not been fertilized. The effect was, however, somewhat more marked on sandy and sandy loam soils than on red clay soils. The most marked effect was obtained from the use of heavy applications of phosphoric acid.

> As carriers of phosphoric acid, acid phosphate, basic slag, and finely ground phosphate rock have been tested, and all have been found to hasten the maturity of cotton, as shown by the percentage of seed cotton open at first and second pickings. In fact, the hastening of the maturity was decidedly more marked from phosphatic fertilizing materials than from carriers of potash and nitrogen tried. Increasing the quantity of phosphoric acid derived from acid phosphate with normal amounts of potash and nitrogen was attended by a gradual increase in the percentage of total seed cotton open at the first picking.

Nitrogen was more effective than potash in hastening maturity. Air-slaked lime did not hasten maturity, but when used in connection with other fertilizing materials increased their effect in hastening maturity. It was observed that—

> When 196 pounds of acid phosphate was added to an application consisting of a mixture of 48 pounds of manure salt and 78 pounds of dried blood, there was almost 13 per cent increase in seed cotton open of total crop at the first picking and more than 7 per cent increase at the end of the second picking. This application also gave 22 per cent at the first picking and 12 per cent at the end of second picking more of the total yield open than was secured from the adjoining plat which had received no fertilizer treatment.
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> Basic slag was found to hasten maturity even more than acid phosphate, as was shown by practically one-half of the cotton being open at the first picking on the plat which received an application of this material in connection with normal quantities of manure salt and dried blood (48 pounds of manure salt and 78 pounds of dried blood). On the plat to which phosphoric acid, in connection with normal application of potash and nitrogen, was supplied from acid phosphate, it was found that about 12½ per cent less of total cotton opened at the first picking than did on the plat from which the phosphoric acid in equal quantities was furnished from basic slag under the

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[1] Compiled from North Carolina Sta. Rpt. 1909, p. 37.

same conditions. When this latter material was applied in the drill in connection with a ton of stable manure per acre, the effects upon hastening maturity were markedly reduced.

Where high-grade, finely ground phosphate rock as a carrier of phosphoric acid was used at the rate of 274 pounds per acre (four times normal phosphoric acid) in connection with a ton of stable manure, and both were applied in the drill, it was noted that the percentage of total seed cotton open at the first picking was about 35 per cent and at the end of the second more than 20 per cent greater than on an unfertilized plat adjacent.

THE SCUPPERNONG AS A PROFITABLE CROP.[1]

In recent years the growing of scuppernongs for wine making has developed into a local industry of considerable importance. In a recent report of the North Carolina Experiment Station, W. C. Etheridge describes methods of growing and keeping the grapes and the processes of wine making locally used.

A large part of North Carolina, particularly the eastern sound-bordering counties, offers an opportunity to the farmers located therein for the development of a substantial industry which may be carried on to advantage along with the usual farm operations of the locality, or taken singly and more extensively.

This is the growing for commercial purposes of scuppernong grapes, to which the section is ideally adapted in soil and climate. With such natural advantages there is wonder that this industry remains undeveloped when the only other factor wanting is a market, the lack of which may be attributed more to an absence of enterprise in seeking than to its nonexistence, for undoubtedly with some effort and advertising a market could be found for the delicious light wine that may be produced from the scuppernong grape. There are, to be sure, a few large vineyards in the State operated on a commercial basis by several wine companies of another State; but with the small farmer, to whom the scuppernong might be made to yield as reliable revenue as his staple crops, the industry is dormant.

The vines are always propagated from runners which may be had from any established vine by pulling or digging up the overhanging and rooted branches. These should be set out in the fall, and may be trained either on a scaffold or trellis, the former requiring less attention, while the latter affords easier access for pruning and gathering the fruit and gives the vine more fruit-bearing surface. If a scaffolding is used, the main posts should be of fat pine, if obtainable, as these will last indefinitely, although cypress and juniper make very good ones if the part that is to be buried is given a coating of tar. The running poles are best if of large cypress, or juniper saplings, 3 to 5 inches in diameter, stripped of their bark; yet any sort of pole or rail may be used for this purpose, as it may easily be replaced when rotten. If trellising is preferred, convenience may again be regarded in the selection of posts, as on account of their small size it is not difficult to replace them when needed.

Although a trellised vine would require more attentive pruning, the work of the South Carolina Station, as reported in a previous bulletin of this series,[2] indicates that whether grown on arbor or trellis the vines will succeed better if rightly pruned.

For making wine only ripe and perfectly sound grapes should be used. When fully ripe they are shaken into large sheets of burlap, or cloth, spread underneath the vine, the shaking being easily accomplished by jarring the vine with a pole crotched at one end, by which a hold is obtained on the vine. Such trash from the vine, leaves and broken bits of stems or twigs, as may have fallen into the sheet is carefully picked out and the grapes are ready for the press.

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[1] Compiled from North Carolina Sta. Rpt. 1909, p. 117. [2] U. S. Dept. Agr., Farmers' Bul. 374, p. 11.

The process is very simple, being only a flat, shallow trough about 8 feet long, 3½ feet wide at one end, tapering down to about 18 inches at the other, and having fixed at about 30 inches from the wider end a wooden roller 6 or 8 inches in diameter. This roller is covered spirally with strips of leather, which give it a better catch on the grapes and make it less liable to smash the seed than if its surface were bare. To either or both ends is fitted a crank for turning. When in use the trough is fixed between four posts at a convenient height for pouring in the grapes and is slightly inclined for the flow of the juice. The grapes are poured into the trough behind the roller, and it is slowly turned over them, crushing out the juice, which is received into a pail or tub placed beneath the lower end of the trough and is then strained into stands usually made by sawing a good oaken barrel through the middle. The juice is afterwards filtered through some material that will catch the smaller rags of pulp and broken bits of seed which have escaped the strainer. A filter commonly used in the eastern part of the State is made of small pieces of sea shells wrapped or mixed with clean, bright broom grass and placed in a large funnel. This is very effective in clearing the juice.

After filtering, the juice is transferred to barrels, where it may be sweetened at once or after fermentation, this depending upon the quality of wine desired. If the sweetening is done before the juice ferments the wine retains much of the mild, natural flavor of the ripe fruit, but does not have the body, or "tang," that results if fermentation is first allowed. The amount of sugar to be used in sweetening is between 2 and 3 pounds per gallon of juice, and varies with the time the wine is to be kept; if it is intended for use within a year or two, less sugar is required than if the wine is to be aged; and less is needed if the sweetening is done before than after fermentation. After the juice is in the barrels the bungs are left out until all the fermentative gases have escaped, and are then driven tightly in.

Converting the fruit into wine is easily the most profitable disposal that can be made of it, provided a market can be found. A bushel of grapes will yield, even with the present crude methods of pressing, 3 gallons of wine, exclusive of the sugar added in sweetening. This should sell for at least $2 per gallon, making a gross return of $6 per bushel for the grapes. The cost of making the wine is small, as the method is a simple and easy one, requiring little skill and no apparatus that may not be provided at home. The only material entering into the process that need call for a direct expenditure is the sugar used in sweetening, and even this is used at a profit, as it increases the volume of the wine in about the same proportion as its own volume, the value of the extra quantity of wine produced exceeding the cost of the sugar.

EARLY SPRING LAMBS IN THE SOUTH.[1]

In a bulletin of the Alabama Experiment Station D. T. Gray and J. W. Ridgway strongly advocate increased attention to animal production in the South, pointing out especially the many natural advantages of that region for sheep raising.

The northern farmer must be contented with a grazing period of 6 months or less and must give early lambs expensive hothouse treatment during the cold winter months, while a large part of the South can have permanent pastures for 10 months in the year by the use of Bermuda grass, bur clover, and Japan clover. Temporary winter pastures may be resorted to during the remaining 2 months, thus giving the advantage of pasture 12 months in the year.

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[1] Compiled from Alabama College Sta. Bul. 148; Missouri Sta. Circ. Inform. 25; Tennessee Sta. Bul. 84.

Sheep raising will insure some return in case the money crop is a total or partial failure. Should the season be too wet for cotton, it will very probably be favorable for the pastures which feed the sheep, and the wool and lambs will furnish a very acceptable source of income. The early lambs will bring returns in the spring, which ordinarily marks a time of low income and considerable expenditure for fertilizer, seed, machinery, and other things necessary for the season's work. Another advantage is that sheep require most attention at the time when southern crops need little or no attention.

There is always a good demand for the early, or spring, lamb. Should the local market not demand all that the farmer can produce, they can be shipped to the larger cities, for prices are often sufficiently high to justify the payment of express charges. The early lamb is usually born in December or early January and ready for market by the middle of April in Alabama, but in Tennessee the season is somewhat later. According to a court ruling, a spring lamb there is one born after January 1. The Tennessee lamb brings the best price between May 25 and June 15, after which the Kentucky lamb becomes a more active competitor, and prices become lower.

A good winter range or canebrake will furnish ample feed for the ewes, which will require no further attention under these conditions, save at lambing time, but the small farmer usually does not have these facilities. This does not prevent the sheep from being especially adapted to the needs of the farmer with little capital. Oats, vetch, rye, wheat, bur clover, and barley pastures may readily be resorted to. The southern ewe, which quite generally prevails south of Nashville, Tenn., and is usually secured as a basis of the flock, may be had at prices ranging from $2.50 to $4.50. When crossed with a Down ram, a medium good lamb for spring market is the result. These ewes will increase from a purchase weight of 80 to 90 pounds to 125 or 130 pounds when the lamb is sold in the spring. However, until the increase in the spring lamb trade exhausted the supply, the Tennessee farmer usually bought when possible the native mountain ewe, bred largely on the Cumberland Plateau or the Highland Rim. This ewe is most common north and east of Nashville, and is a leggy, heavy-boned sheep, in some respects resembling the Leicester.

At the Alabama Experiment Station a flock of scrub and grade ewes, headed by a Southdown ram, was handled under conditions similar to those of the average small farm of that State. During the summer months no attention was given to the sheep on pasture except to see that they had plenty of water and a mixture of 1 part of tobacco dust and 4 parts of salt at all times to keep down stomach worms. When the worms are troublesome the flock should be changed from pasture to pasture as frequently as possible, except when on a large range, to prevent or check reinfestation by worms.

As the lambs were to be dropped in December or early January, the ewes were "flushed" by turning them on fresh pasture and giving them a little cottonseed meal daily during July and August preceding the breeding season. The ewes were kept neither too fat nor too poor during these months. The station ram was allowed to run with the flock at all times, but had there been as many as 50 ewes he would have been kept away during the day.

Although many southern farmers feed nothing but cottonseed meal and hulls to the ewes, others avoid cottonseed and its products, claiming that they cause blindness, dizziness, and sometimes death. To test this point the old flock was divided into two lots, one of which was fed upon soy-bean hay alone and the other upon cottonseed meal and hulls. No bad results are reported from either feed. Both lots of ewes came to the lambing period in excellent health and spirit, but those fed on cottonseed meal seemed more alert and spirited than the soy-bean lot. Notwithstanding these favorable results in feeding cottonseed meal, some caution is necessary in feeding it. Recent investigations by Dr. Crawford, of the Department of Agriculture, indicate that cottonseed meal contains a salt of pyrophosphoric acid, which may cause serious trouble. Probably some kinds of cottonseed contain this poisonous matter in larger amounts than others, which may account for the fact that some feeders have had trouble and some have not. Unless the seed fed has been tested in some way, only small quantities should be used at first. During four years' work at this station no ill results have come from the use of cottonseed meal as a feed for sheep, save possibly in one case in 1906. The daily feed eaten by each ewe was 0.5 pound of cottonseed meal and 1.3 pounds of cottonseed hulls, costing 30 cents per month per ewe for this lot, and 1.9 pounds per day of soy-bean hay, costing 35 cents per month per ewe. The total gains per ewe for 106 days were 1.8 pounds for the cottonseed lot and 1.6 pounds for those fed on soy-bean hay. The animals averaged about 95 pounds in weight.

The small farm, as usually managed, does not afford green feed throughout the year, so it is necessary to know what increase would be made in the feed given the ewes after lambing. The majority of owners allow animals to run down in flesh at this time, and even the writers on the subject estimate the necessary increase of feed at only 25 per cent. In view of the results of experimental work with grade Angus cows, Prof. Mumford, of the University of Illinois, says:[1] "In this test it took approximately twice as much feed to maintain a cow suckling a calf as it did during her pregnancy." Accordingly the feed of these ewes was doubled in amount, but as they immediately began to increase in weight the amount was reduced until they were receiving 75 per cent more cottonseed meal and 81 per cent more hulls than when dry. These amounts were found to maintain them without material increase or decrease of weight. The cost per ewe per month on this ration was 54 cents.

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[1] Illinois Sta. Bul. 111, p. 338.

If the purposes of the experiment had not compelled the continuance of the animals on the dry feed, the most economical method of management would have been to turn ewes and lambs upon the green pastures. Under the conditions only the lambs were permitted to run on the pasture of fall-planted oats and vetch, which were ready for grazing by the time the lambs could use them. Any animal makes its cheapest gains when young, so it pays to feed the lambs well. They will begin to eat when about 10 days old. Although they will eat but little corn, the 6.6 bushels of coarsely ground corn which 14 lambs ate helped to finish them for market at an earlier date. They were sold at an average age of 101 days and an average live weight, at Atlanta, of 51 pounds. While the station accounts show a profit of only $10.11 on the transaction, it must be remembered that for the purposes of the experiment an uneconomical method of feeding the ewes was followed, and that in addition to bringing this profit they had furnished a market for the feed consumed at the rate of $25 per ton for cottonseed meal, $6 per ton for hulls, $12.50 per ton for soybean hay, and 10 cents per month per sheep for pasture, and that the fertilizing elements of these crops were retained on the farm in a form fully as valuable, weight for weight, as many commercial fertilizers for which high prices are being paid.

The earliest bunch was sent to Atlanta to market April 23. Two of the lambs sold for 9 cents per pound, live weight, 3 for 8½ cents, and the remainder marketed later at 8 cents per pound. The fact that the later ones were of better quality emphasizes the importance of marketing before the weather becomes warm and the demand weakens. The market opens with what is known as the Easter lamb, one which is of good quality and weighs from 40 to 45 pounds. Although the Easter lamb from Tennessee will sell at from 9 to 12 cents, it holds the same position in the sheep market that the Christmas steer does in the beef market, and a few loads will supply the demand. Any surplus is a drug on the market. It does not pay to market a lamb at 40 pounds, since the ewe must be maintained an entire year and the lamb may be made to weigh 80 pounds at practically the same cost required to bring it to 40 pounds.

Experiments at the Missouri Agricultural Experiment Station show that the best gains were made by fattening sheep when corn formed a part or all of the ration and that a better finish resulted, while a ration of wheat bran exclusively proved inferior for fattening lambs. A feeder from which the animals were able to supply themselves with grain at all times proved too expensive to be recommended. When roots formed a part of the ration better gains were made and less dry matter required to produce a pound of gain. Shearing late in winter increased the weight of gain, but shearing December 1 was not followed by good results. Animals fattened on rape during the fall were as successful feeders as those pastured on grass during the same period.

An Alabama farmer, who started with scrub ewes and tries to keep about 100 ewes in the pasture with 150 cattle, writes the experiment station that "our investment in sheep has never paid us less than 100 per cent and many years has paid us even more than that. The higher we grade them up the better they pay us, notwithstanding the fact that the higher they are graded up the greater price we place upon the breeding flock." The same writer sums up the advantages of sheep raising on the southern farm in these sentences: "They require but a small capital to begin the business. They will do well on hilly and broken lands. Their manure is one of the richest animal manures that can be obtained. The money comes in from them in the spring and early summer when money is scarce. They subsist on things that other animals will not eat. They afford us two sources of profit—wool and lambs."

THE PRODUCTION OF SANITARY MILK.[1]

The great problem in the production of sanitary milk is to exclude bacteria. It is commonly understood that to prevent contamination of the milk the cow stables, milk utensils, and the milker should be kept as clean as possible, and that the stable should be so constructed that it may be easily and thoroughly cleaned. The air of the stable should be as free as possible from dust when milking. Some of these factors which enter into the production of sanitary milk have been discussed in a previous bulletin of this series.[2]

Recently the Virginia Station has determined the number of bacteria and the relative importance of observing these and other precautions taken to avoid contamination. By actual count it was found that sprinkling the straw bedding, so as to prevent dust and bacteria from arising, the percentage of bacteria in the milk was reduced 53 per cent. A reduction of 25 per cent was secured when a closed pail was used in milking as compared with an open pail. About 23 per cent of the bacteria were eliminated when the flanks of the well-cleaned cows were moistened before milking. Discarding the first four strippings from each teat was also of some importance in reducing the bacterial count. These four precautions—sprinkling the bedding, moistening the flanks of the cow, using a closed pail, and discarding the first strippings—can be observed without any appreciable expense, and no dairyman can afford to neglect them.

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[1] Compiled from Virginia Sta. Bul. 185.

[2] See U. S. Dept. Agr. Farmers' Bul. 273, p. 23.

An experiment was also conducted by the same station to test the relative value of straw and sawdust as bedding. The stable was bedded half with straw and half with sawdust. By actual count there was an average of more than twice as many bacteria when straw was used as when sawdust was used. On the other hand, sawdust is of little value as a manure and to some extent detracts from the value of the droppings of the cow, while straw is a good absorbent and has a value of its own as a fertilizer.

When a milking machine is used some precaution for preventing the development of bacteria in the rubber parts must be observed. Soaking these parts in limewater is effective, and when this is done the milk from a milking machine should contain no more bacteria than when the cows are hand milked.

LACTO: A NEW AND HEALTHFUL FROZEN DAIRY PRODUCT.[1]

In a recent bulletin of the Iowa Experiment Station, M. Mortensen and John Gordon describe the preparation of a new frozen product made of loppered whole or skim milk with the addition of eggs, sugar, lemons, and flavoring material, which it is claimed has a more pleasing flavor than sherbets and ices and contains considerably more nutriment. This product, for which the name "lacto" is proposed, is thought to have medicinal as well as nutritive value on account of its acidity, resulting from lactic-acid bacteria. The preparation of the product is described as follows:

PREPARATION OF MILK USED FOR MANUFACTURE OF LACTO.

The milk for lacto is prepared in a similar manner to the starter which is used for cream ripening. A commercial lactic-acid culture is used. This is added to a pint of skimmed milk which has been pasteurized at a temperature of 85° C. (185 F.) for 20 minutes, and after pasteurization cooled to from 20° to 22° C. (68–71 F.). The lactic-acid culture is mixed thoroughly with the milk and left at 20° C. (68 F.) until the milk has coagulated. Then another bottle of skimmed milk is pasteurized and cooled in the same manner, but instead of the commercial culture a part of the coagulated milk is added to insure the souring of the milk inside of 18 hours. This operation is repeated until the final batch of soured milk obtained has lost the undesirable flavor due to the substance in which the commercial culture was preserved. After this point has been reached, which requires from four to six days, the last sample of soured milk obtained is added to a larger amount of pasteurized skimmed milk. This is then treated the same as the former lots. In this way an amount of milk sufficient to work with is obtained.

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[1] Compiled from Iowa Sta. Bul. 118.

Where lacto is to be made in the household on a small scale it may prove too expensive to buy commercial lactic cultures. A family recipe then would be as follows: Take a bottle of good clean fresh milk which has not been heated, set it away at a temperature of from 68° to 70° F. until it coagulates. If it coagulates as a smooth solid curd without pin holes, if the aroma is clean and pleasant, and the flavor nice and creamy, it can be used as a starter for a larger amount of pasteurized whole or skimmed milk.

The milk when ready to be used for lacto has an acidity of 0.7 to 0.8 of 1 per cent expressed in terms of lactic acid. It must be of a mild and clean acid flavor. The curd must be thoroughly broken up. This is accomplished by pouring it from one pail to another until it is as smooth and velvety as rich cream. From this milk, which in this connection we will call "lacto milk," the various lactos are prepared by the following formulas:

FORMULAS FOR LACTO.

Each of the following formulas will make 5 gallons of the finished product:

- Cherry lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
  - 1 quart of cherry juice or concentrated cherry sirup.
  - 1½ pints lemon juice.
- Orange lacto—
  - 3 gallons lacto milk.
  - 11 pounds sugar.
  - 12 eggs.
  - 2½ quarts orange juice.
  - 1½ pints lemon juice.
- Mint lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
  - 1 pint concentrated crème de menthe sirup.
  - 2½ pints lemon juice.
- Pineapple lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
- Pineapple lacto—Continued.
  - ½ gallon grated pineapple.
  - 1½ pints lemon juice.
- Marachino lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
  - 1 quart marachino cherries grated.
  - 1½ pints cherry juice or concentrated cherry sirup.
  - 1½ pints lemon juice.
- Raspberry lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
  - 1 quart red raspberry juice or concentrated sirup.
  - 1½ pints lemon juice.
- Grape lacto—
  - 3 gallons lacto milk.
  - 9 pounds sugar.
  - 12 eggs.
  - 1 quart grape juice.
  - 1½ pints lemon juice.

PREPARING THE MIXTURE.

The sugar is first dissolved in the lacto milk. The eggs are then prepared. The whites and yokes are kept in separate containers and each lot is beaten with an egg beater. Both the yolks and whites are then added to the milk. The mixture is thoroughly stirred and strained through a fine wire gauze. The fruit juices are added last. If there is any indication of the juices precipitating the casein, they should be left out until the mixture has begun to freeze, when they may be added. The freezer is now run until it turns with difficulty, when the paddle is removed. The brine is removed and the freezer repacked with ice and salt and left for an hour before the contents are served.

The authors see no reason why lacto "should not within a reasonable time become just as popular as sherbet." It has the advantage of having in addition to a pleasant taste considerably more nutriment.

A REENFORCED BRICK SILO.[1]

Having had good results with a brick silo constructed in 1904, the West Virginia Station undertook, in 1909, to construct a larger reenforced brick silo which should have all of the advantages of the first brick structure, and yet be much less expensive. The construction of this silo is described by Horace Atwood in a recent bulletin of the West Virginia Station as follows:

> An excavation was made about 4 feet deep to the underlying rock in order to secure a solid foundation. Then a cylindrical brick wall was laid up the width of a brick, or 4 inches thick, cement mortar being used. As the wall was laid, 20d. wire nails, which previously had been annealed by heating them, were embedded in the mortar with the ends projecting from the wall about 2 inches into the silo. About two nails were used per square foot of surface.
>
> After the wall had stood a few days for the cement mortar to harden, woven wire fencing was cut into pieces of the proper length to go around the inside of the silo, lapping somewhat, and the projecting ends of the nails were clinched over the wires so as to hold the fencing close to the brick wall * * *.
>
> Only fencing with straight horizontal wires should be used for this purpose, for if the fencing is not drawn close to the wall in all places an unnecessary amount of cement is required for the plastering.
>
> Two thicknesses of wire fencing were put on for about one-half of the depth of the silo and for the remainder only one thickness. Each strip of fencing as put on was lapped about 2 inches over the lower one. The top course of fencing was allowed to project about 4 inches above the top of the wall and this was stapled to the plate, thus fastening the roof securely to the structure.
>
> After the wire was in place the inside of the silo was plastered with cement mortar, thus covering the wire. The mortar consisted of one part of cement and three parts of sand.
>
> Four openings were provided at convenient distances for removing the silage. These openings are each 24 by 30 inches in size. The door frames are of cast iron 1 inch in thickness, with a projection which laps a couple of inches over the brickwork on the inside of the silo. There is also a projection an inch high extending around the frame on the inside and 2 inches from the face of the frame and against which the door presses when in place.
>
> The doors were made, as is customary, of two thicknesses of seven-eighths inch flooring, with roofing paper between, and they are held in place by being bolted to 4 by 4 inch pieces of timber, which extend across the door frames on the outside. The nuts on the bolts which pass through the doors and the pieces of timber are tightened from the outside, and in this way the doors can be drawn snugly against the jamb of the door frames.
>
> This silo has been used only one year, but the silage has kept well and the wall successfully withstood the internal pressure.
>
> It is believed that this method of construction possesses many advantages where a permanent structure is desired. The wire fencing, being protected by the coating

---

[1] Compiled from West Virginia Sta. Bul. 129.

of cement, has no tendency to rust and the life of the silo should be almost indefinite. In every agricultural community the services of a brick mason can be secured easily, the job of laying up the 4-inch wall is a short one, and the farmer himself can put on the wire and do the plastering.

The following statement shows the amount and cost of materials and the cost of construction for a silo 15 feet in diameter and 30 feet deep.

Materials used and cost of construction for silo 15 feet in diameter and 30 feet deep.

8,600 brick	$59.20
Laying brick	76.39
233⅓ bushels sand	4.66
9½ barrels cement	19.00
Plastering silo	41.20
3 rolls woven-wire fencing	14.00
½ keg of 20d. wire nails	1.50
Lumber for roof	38.90
3,250 shingles for roof	13.00
Carpenter putting on roof and building doors	15.00
4 cast-iron door frames	18.18
Labor excavating foundation	12.00
Total cost	313.03

If, as pointed out above, all of the work except laying the bricks be done by the farmer himself, the actual cash outlay would be much less than that given above.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 458.

THE BEST TWO SWEET SORGHUMS FOR FORAGE.

BY

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*Scientific Assistant, Forage-Crop Investigations,
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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 14, 1911.

Sir: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a paper entitled "The Best Two Sweet Sorghums for Forage," prepared by Mr. A. B. Conner, Scientific Assistant in the Office of Forage-Crop Investigations of this Bureau, under the direction of the Agrostologist in Charge.

At this time the several different sorghum varieties are grown promiscuously over the entire region adapted to this crop. This bulletin is prepared with a view to helping the farmer find the variety best suited to his region and to grow and improve this variety so as to obtain better yields of forage. The publication of such information should result in great benefit to the farmers throughout the sorghum region.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—658.

THE BEST TWO SWEET SORGHUMS FOR FORAGE.

INTRODUCTION.

Since sweet sorghum is not a money crop, its value and real worth to the farm are seldom recognized. It is a well-established fact that our greatest returns from the farm come in the way of products that are fed to animals and thus indirectly sold. In any feeding operation roughage is a necessity, and to feed most successfully from an economic standpoint one must secure the best forage to be had and at the same time one that is cheaply produced. As a roughage that is cheap and yet wholesome sorghum hay when properly cured has no equal, at least in the region where it is grown.

Aside from feeding in conjunction with concentrates, sorghum is extensively used as a supplementary feed for range stock. By its use the farmer or stockman is not infrequently enabled to carry one-third more animals per acre. All this, along with the fact that the sorghums can be grown successfully in many different types of soils under varying conditions with less difficulty than most other crops, makes it of vital importance that their growth be extended into every possible section.

Every grower should obtain a knowledge of the leading varieties, those best adapted to his region, how to grow the best yields of forage, and when and how to make his selections for the improvement of the variety. In this manner not only can a cheap forage be more widely grown, but the cost of producing it can be lessened. A more extended growth of sorghum would also supply the demand for hay to feed along with corn in the Southern and Southwestern States. This demand is very urgent. It is therefore the purpose of this publication to point out the best varieties, their area of growth, the means of getting better yields, and the best and quickest method of improving the strains for their forage value.

CLASSIFICATION AND VARIETIES OF SORGHUM.

The sorghums are divided into two general classes: (1) Those that are grown primarily for forage and sirup and (2) those that are grown for grain. The varieties of the first group are also known as the saccharine or sweet sorghums, because of the high percentage of sugar contained in the stems. They are readily distinguished by their high saccharine content, the usually light seed head, and the large amount of tannin contained in the seed. This tannin is noticeable even after the seeds are ripe. The grain-producing varieties are sometimes known as the nonsaccharine sorghums and usually have a pithy or semipithy stem which contains little saccharine matter. They are generally recognized by their larger seed heads and their large seeds, which usually contain very little or no tannin.

Of the saccharine sorghums, the size, shape, and color of the seed head, as well as the size, shape, and color of the hulls and seeds, determine the type and variety to which they belong. There are seven important varieties, or varietal groups, of these sorghums, namely, Sumac, Amber, Orange, Planter, Gooseneck, Honey, and Sapling. The first five of these are of commercial importance. These varieties are described in this bulletin in the order of their value.

The descriptions and the comparative figures presented in Table I are from data secured in northwestern Texas and are therefore applicable directly to that region. Although the yield, time required for maturing, leafiness, etc., vary with the section in which they are grown, nevertheless these data will help the grower to form an estimate of the comparative values of the most common forage varieties and to judge what can be ordinarily expected of each. In enabling the farmer to secure the variety best suited to his region and conditions these data are important.

TABLE I.—*Growing period, yield, leafiness, and other qualities of the best eight forage sorghums.*

Variety.	Growing period.	Yield.	Number of leaves.	Sweetness.[1]	Juiciness.[1]	Tenderness.[1]	Objections.
	Days.	*Tons.*		*Per cent.*	*Per cent.*	*Per cent.*	
Red Amber....	92	4½	10 to 11	85	90	100	Suckers
Minnesota Amber.	94	4	9 to 10	86	70	80	Do.
Orange.........	98 to 108	6	11 to 12	80	80	90	Subject to blight.
Planter.........	102 to 112	6½	11 to 12	33	60	85	Lodges.
Sumac..........	108 to 114	7½	14 to 16	90	95	80	Late.
Gooseneck......	114 to 120	7½	14 to 16	100	100	75	Coarse, late.
Honey..........	112 to 118	7½	14 to 16	100	100	80	Late.
Sapling.........	108 to 114	5½	11 to 13	80	80	80	Lodges.

[1] Estimated.

SUMAC.

Sumac sorghum is the sweetest, the leafiest, and the heaviest yielder of the strictly forage varieties. It is one of the latest maturing sorghums, producing seed in from 108 to 114 days. The plant is rather stocky, bearing 14 to 16 leaves and a small, compact, dark-red seed head. This seed head is made up of small, round, dark-red seeds about the size of duck shot. The seeds are only partially inclosed by short, dark-colored, round glumes. This variety, unlike the others, is not readily cross-pollinated by other varieties.

AMBER.

Amber sorghums are easily recognized by the slender stems, few leaves, and open, longer branching seed heads. The stems are tender, juicy, and sweet. This is the earliest maturing variety, producing seed in from 90 to 94 days. The seeds are larger than those of Sumac, yellowish brown in color, and rather elliptical in shape, and are nearly inclosed by large, pointed hulls, which are either black or red, depending on the strain. The Amber is the lightest yielder of all, but on account of its earliness it is especially adapted to the northern region. The best two strains of Amber are the Red, which has a reddish-colored seed head, and the Minnesota, which has a dark-colored seed head.

ORANGE.

The stalk of Orange sorghum is rather large and stocky. It is less leafy than Sumac and the stem contains less juice and sugar. This stalk bears a rather compact seed head, 7 to 8 inches long. Because of the color of the hulls, which are pointed and inclose about two-thirds of the seed, the heads have a dark-brown appearance. The seeds are about the size of and somewhat less elliptical than those of Amber and somewhat larger than Sumac seed. Orange is slightly earlier than Sumac, but does not yield as heavily. If left until overripe it will be more readily attacked by spot blight than any other sorghum. It is adapted to about the same area as Sumac, though it has no advantage over it except in earliness.

PLANTER.

Planter sorghum is readily distinguished from the Orange, which it most resembles, by having a light, straw-brown seed head, which may be either open and drooping or compact. The light, straw-colored seeds are plump and half or more are inclosed by light-brown, very pointed hulls. Its stems are about as stocky and as leafy as Orange, but lack in juice and sugar content. Planter is somewhat later than Orange and is perhaps a heavier forage yielder, but lodges badly if attacked by chinch bugs. It is not considered a very desirable variety.

GOOSENECK.

Gooseneck is a tall, coarse-growing variety (12 to 14 feet high), the stems of which are exceedingly juicy and very sweet. It is quite leafy and produces heads that are either goosenecked or more or less inclined. The head is black and nearly as wide as it is long. The seeds are yellowish brown in color and somewhat smaller than Orange seeds, and are entirely inclosed by black, shiny hulls which are more or less compressed at the tip. This variety is later in maturing than Orange, or even Sumac, and therefore can not be grown as far north. It is primarily a sirup sorghum, but has some value for forage purposes.

HONEY.

Honey sorghum is a medium-tall but not an unusually coarse-growing type. Its stems are very leafy, juicy, and sweet. The seed head is always erect, reddish in color, and of a rather open, broomcorn type. The seeds are elliptical in shape and are almost entirely inclosed by reddish, shiny hulls. It is one of the best sirup-producing sorghums, and on account of its tendency to slenderness and its leafiness it promises to be a valuable forage sort for the Southern States.

SAPLING.

Sapling is also a tall-growing variety, but is more slender than Gooseneck. Its joints are longer and it is consequently not so leafy as Gooseneck. The plant bears a long, erect head, cylindrical in shape, and resembling in general appearance the head of Red Kafir. The seeds are brownish red and about one-half inclosed by short, black hulls. The stem of this variety is not as sweet and juicy as that of Sumac. Although of some value for sirup, it is not considered a desirable forage type.

THE BEST TWO SWEET SORGHUMS AND THEIR GROWING AREA.

The best sorghum variety for any region must not only be a good yielder of forage, but must give a forage of good quality. Unlike many other crops, therefore, the heaviest yielder is not always the best variety. Furthermore, the cost of producing and harvesting the crop must be taken into account. Considering these things, the Sumac and the Amber are the best two types for the sorghum region, the former for the southern and the latter for the northern section (figs. 1 and 2). The Sumac is best for the southern region for the reason that it excels both in quality and in yield any other standard forage variety and produces this forage at a relatively smaller cost. The Amber, being early, is the only variety that is sure to mature in the northern section; hence it is the best variety for that region.

In the southern region all types mature. The early-maturing sorts give the greatest number of cuttings, but the yield per cutting is relatively small, so that the total forage for a season is perhaps less than that from the late-maturing varieties, which give fewer cuttings but heavier yields per cutting. Furthermore, the total cost of harvesting the early types, on account of the increased number of cuttings, is greater, which makes them less profitable and less desirable in this region. This is the case with Amber sorghum, yet a considerable acreage of this variety is grown in the Southern States. The Gooseneck, Honey, and Sapling varieties are rarely grown for forage on account of the coarseness of the fodder, but they are excellent sirup varieties. The Planter is grown more or less extensively in certain limited sections in the semiarid region, but its undesirable habit of lodging, together with its small yield of juice, makes it inferior to the Sumac. The Orange is an excellent forage variety, but it matures under about the same conditions and in about the same time as Sumac and its forage yield is smaller. For these reasons it is pretty generally conceded to be less profitable. The Sumac, therefore, is undoubtedly the best forage type for the southern region and its cultivation should replace that of all others.

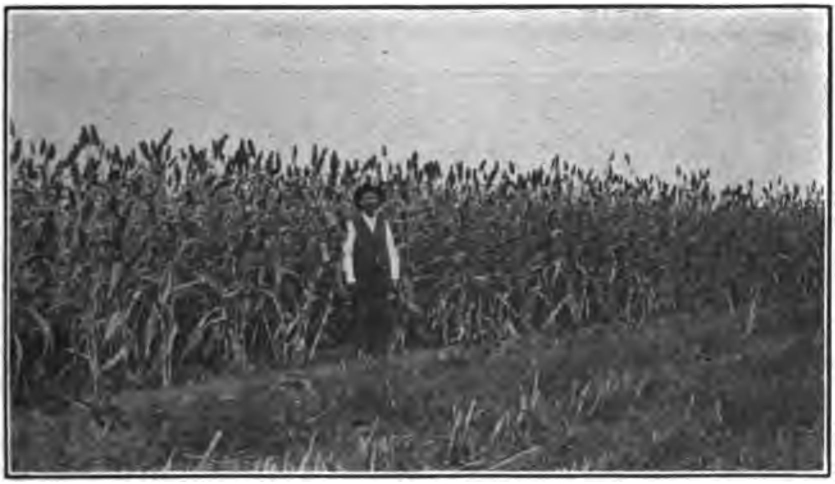

FIG. 1.—Field of Sumac sorghum grown in wide rows for forage and seed. Note the compact seed head and great number of leaves.

The accompanying map (fig. 3) shows the region where Sumac sorghum should be grown.

Sumac has long been grown in portions of the Southern States, particularly in central and northwestern Texas, in parts of Oklahoma, Arkansas, Tennessee, and southward. Figure 4 shows the luxuriant growth of this variety.

It is recognized by many farmers in this region as the best forage sorghum. Nevertheless, considerable Amber is grown in the belief that it produces heavier total yields by giving a greater number of cuttings, which incidentally reduces the risk of losing hay by rains.

It is definitely known that Sumac matures easily as far north as Kansas and the northern boundary of Tennessee. Tests thus far indicate that it will produce good forage as far north as central Kansas, central Missouri, and the Ohio River. Since the remaining varieties range so close to it in time of maturity that they are of little value north of the probable Sumac area, this variety is recommended for the entire region shown on the map in figure 3.

In the northern region only an early variety will mature good seed. The Amber therefore occupies this entire section by virtue of its earliness. Although it is now grown over a considerable portion of this region, it is by no means as widely grown as it should be. By selecting early strains it can be extended even farther north than it is at present grown. The accompanying map (fig. 5) shows the region where Amber sorghum should be grown.

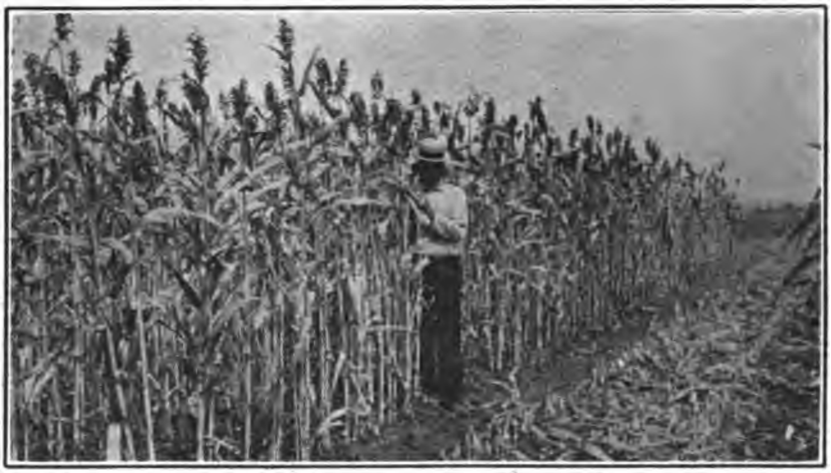

FIG. 2.—Field of Red Amber sorghum grown in wide rows. Compare the open seed head and few leaves of this variety with the compact head and leafiness of Sumac.

The Minnesota Amber variety is now widely grown throughout the region shown by this map (fig. 5). It is an excellent strain. The Red Amber is little known in this region at the present time.

Figures 6 and 7, respectively, show fields of Sumac and Red Amber sorghum grown thickly for hay.

Tests of the Red and the Minnesota varieties have indicated that under the same conditions the Red Amber is somewhat earlier, and it is undoubtedly more tender and perhaps sweeter and juicier than the Minnesota Amber. Early strains of the Red Amber are therefore recommended over the Minnesota variety. Either of these sorghums will produce good forage even farther north than it will mature seed, and therefore the northern limit can be determined with little risk on the part of the farmer.

FACTORS LIMITING THE GROWTH OF SORGHUM.

Although the sorghum area has spread widely in the past few years, its growth has not progressed as it should, because of several factors, the most important of which are the scarcity of seed, inferior grades of seed, bad effect on land, and failure to harvest and cure the hay properly.

SCARCITY OF SEED.

The supply of sorghum seed in recent years has been very limited, largely due to the destruction of the seed crop in the more humid sections by the sorghum midge and to the failure to get seed crops in the drier regions. The damage done by the sorghum midge is often so great that infested regions produce absolutely no seed. The midge region includes the more humid portions of all the Southern States, reducing the dependable seed-producing area about one-half. The work of this midge, which results in the failure of the crop to set seeds, is the so-called " blast " known in recent years throughout the infested section. This midge (*Diplosis sorghicola*) is so small that ordinarily it escapes notice when depositing its egg on the ovary at flowering time. The egg produces a larva which feeds on the juices of the ovary, preventing the formation of seed. Since moist, damp weather is most favorable to this midge, it will probably not become a serious pest in the drier regions, upon which, therefore, dependence for the supply of seed must rest. Throughout the semiarid portions

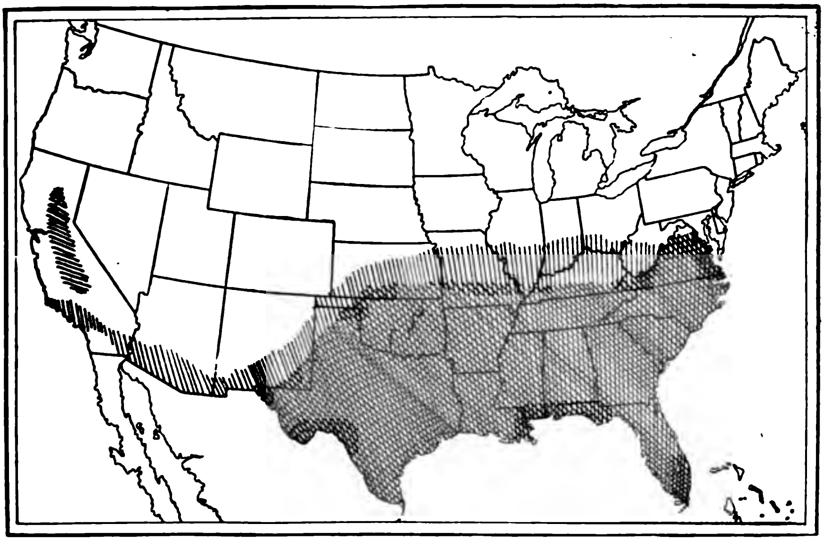

FIG. 3.—Map of the United States, the more densely shaded portion showing the region where Sumac sorghum is known to be the best forage variety, and the lighter shaded portion showing where it will probably prove to be the best variety.

of western Oklahoma, western and northwestern Texas, eastern New Mexico, and western Kansas good seed crops are produced, and the business of growing pure and improved sorghum seed in these sections should be very profitable, since there will probably always be a good demand. The sorghum seed-producing area is further reduced by failures to get seed crops in the drier regions, either because of drought or too thick planting. In considering the quantity of sorghum planted broadcast and thickly in rows for hay it is readily seen that this feature alone will greatly affect seed production.

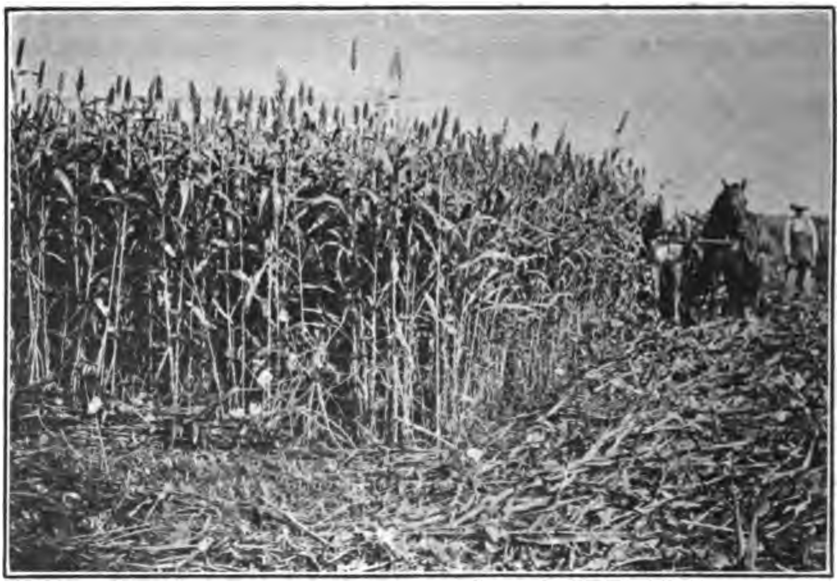

FIG. 4.—An excellent field of Sumac sorghum, showing the enormous growth made in close drills.

INFERIOR GRADES OF SEED.

A considerable portion of the seed now on the market is more or less mixed with other varieties, partly because of failure to rogue out fields grown for seed and partly because of carelessness in thrashing. Especially is this true after seasons of light seed crops and in the newer regions into which the growth of sorghum is being extended. This seed is put on the market, and is generally sold to the farmer and planted by him as if it were good seed. Such seed will not give a crop that can be harvested at the proper stage, and the hay will therefore be of very inferior quality. Furthermore, the farmer will not as a rule save seed for his own use from such a field; and if it is his first attempt at growing sorghum his idea of its yield and feeding value will be very greatly lowered. Such unsatisfactory crops can not but tend to discourage the growth of sorghum in regions where there is any doubt of its being a profitable crop.

EFFECT OF THE CROP ON THE LAND.

The sorghums are generally supposed to have a very exhaustive effect upon the land, and in certain sections so great is this prejudice that they are but little grown. This idea is largely erroneous, for as a matter of fact sorghum is no more exhaustive than any other crop which produces an equal tonnage. The ill effects are due largely to the bad physical condition in which the sorghum leaves the land. By plowing the stubble early or running out the rows with a turning plow and later harrowing, the land will be left in excellent condition for the succeeding crop. In certain parts of the semiarid region successive crops of sorghum have been grown on the same land for periods of several years without a noticeable decrease in fertility. It is safe to say that with reasonable rotation of crops and early plowing sorghum can be grown with as little ill effect on the land as any other crop except legumes.

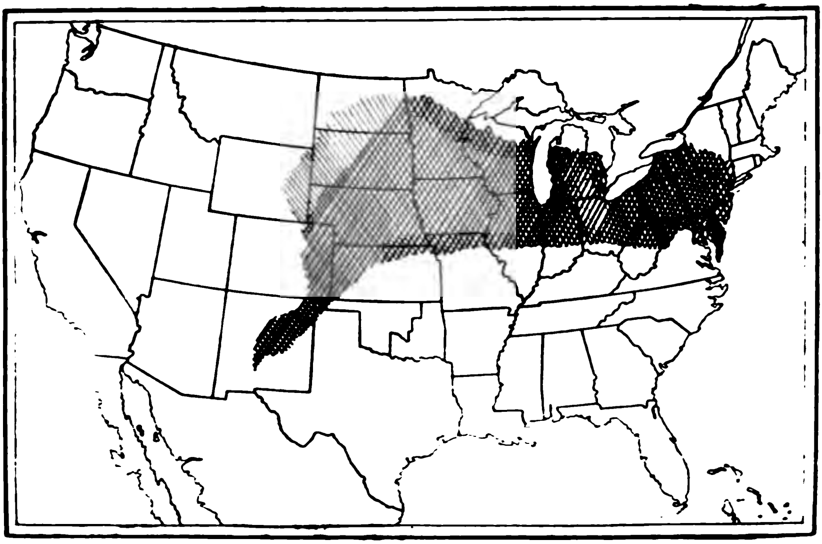

FIG. 5.—Map of the United States, the more densely shaded portion showing the region where Amber sorghum is known to be the best variety, and the lighter shaded portion showing where it is most likely to become a profitable crop.

FAILURE TO HARVEST AND CURE SORGHUM PROPERLY.

Much sorghum hay is improperly harvested by letting it stand until overripe, losing a great portion of its feeding value. Frequently the hay is cut and improperly cured, with the result that it is less palatable and oftentimes low in feeding value. In such cases, even though the fault is with the grower, the tendency is to regard this crop as producing a poor grade of hay. This underestimate of its value is not favorable to extending its growth in newer sections.

GROWING THE BEST FORAGE YIELDS OF SORGHUM.

Although the average hay yield of sorghum is perhaps greater than that of any other annual, it can be greatly increased by observing a few vital points in the growth of this crop. While good seed and good preparation of land are necessary to secure large crop yields, other equally important factors, such as time and rate of seeding and manner of planting, must not be neglected. Perhaps at this time more failures to grow heavy yields of sorghum are due to improper seeding than to any other cause, and too great care can not be given to planning and planting the crop. In many cases it would cost no more to produce a heavy yield than it does to grow a poor crop. It is therefore important to point out the principal factors to be considered in the production of heavy yields.

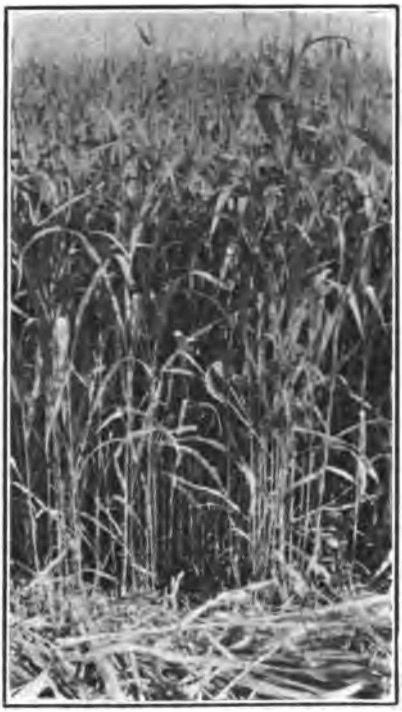

FIG. 6.—Sumac sorghum grown thickly for hay. Note the leafiness and the fineness of the stems.

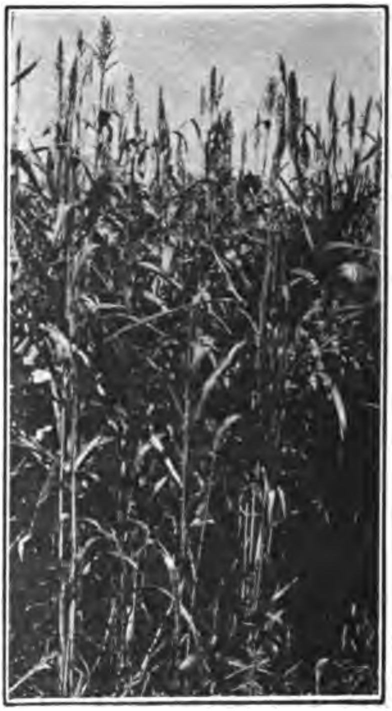

FIG. 7. — Red Amber sorghum grown thickly for hay. Note the few leaves as compared to Sumac.

GOOD SEED.

The farmer can not be too careful in purchasing his seed. Good seed frequently means as much as good tillage, and careful purchases are always to be recommended as a means of increasing the quality and quantity of the crop. In procuring seed the grower (1) should take only the best variety for his locality, that is, the variety that will give the most forage of the best quality, and (2) he should see that this seed is clean and made up of whole grains that have not been cracked while being threshed. The variety should be pure and free from seeds of other varieties. If the seed obtained is trashy and a fanning mill is not available, it can be cleaned by placing it in water. All chaff and light seeds are thus removed, leaving only the clean, heavy seeds. Pure, clean, viable seed insures a uniform, regular stand and a heavier yield of good forage per acre.

THE SEED BED.

Although a large portion of the land planted to sorghum is left unplowed until a short time before planting, this practice is by no means the best. For the heaviest yields, sorghum must have a firm, well-settled seed bed. This can be had by plowing the land as early in the fall as possible and harrowing or disking to keep vegetation down until planting time. Such preparation allows whatever vegetable matter there may be on the land to decay and puts it in the best tillable condition. In the drier regions this treatment serves to take in and retain any moisture that may come during the winter season and to decrease the chance of failure by drought. In the same manner it increases the yield given in case of more favorable seasons. In the more humid region early preparation is preferable, though not so necessary as in the drier regions. The land is sometimes prepared by "bedding" or listing with a middle-buster or a turning plow.

PLANTING.

The planting of sorghum deserves more careful attention than any other operation entering into the production of the crop. The time, method, and rate of planting mean success or failure in the degree in which judgment is shown in putting in the crop. It is of vital importance, therefore, that the farmer carefully plan his seeding operations.

Time.

The sorghums are usually planted as soon after corn as the ground is thoroughly warm. They may be planted at any time from that date to as late as will permit the crop to mature safely. In the Southern States the first of April is considered early planting. To the northward, using the northern line of Louisiana as a base, the season gets later at the rate of about one week for every two degrees of latitude, or 150 miles. As a rule, in the drier regions the sorghums are planted preferably late in the season, as this affords the cured forage less opportunity to dry out too much before feeding time. In sections where the seasons are sufficiently long to give profitable second crops from the stubble, early plantings are always preferred. This is the case throughout the more humid regions of the Southern States. Extremely late plantings are advisable only in cases where it is necessary to plant as a catch crop or as a second crop.

Method.

The sorghums are probably most often planted in close drill rows or broadcast. When such is the case the seeding is done with an ordinary wheat drill or the seed is broadcasted by hand or with a broadcast seeder. In either of the two latter cases a disk harrow or an alfalfa renovator will cover the seeds sufficiently deep to insure germination. Drilling is preferable for the reason that the seeds are more evenly distributed and are put in at a more even depth, which insures a stand with a smaller quantity of seed per acre. In broadcasting there is a tendency to plant on poorly prepared land, which results in the loss of many seeds and at best an irregular stand, although after the crop is several inches high it may appear perfectly uniform.

Throughout a great portion of the sorghum region it is the practice to plant in drill rows 3 or 3½ feet apart. Seedings made in cultivated rows give a greater tonnage than when planted in close drill rows or broadcasted, yet many prefer the latter method because of the fineness of the hay grown. Row plantings may be made in a lister furrow, on the surface, or on a bed. Furrow planting is most common in the drier region, but it is practiced to some extent in portions of the humid section. Surface seeding in the semiarid sections is less common, but as a rule it gives greater yields than deep listing, for the reason that in the latter case the stand is many times injured and even destroyed by heavy rains before or soon after germination. Surface seeding is recommended for the humid and a good portion of the semiarid regions. In any event, seedings in the latter region should not be made in deep furrows. In some of the lower and poorly drained lands plantings are made on the bed, but only under such conditions should this method be practiced.

Rate.

The rate and regularity of seeding largely influence the yield of forage, regardless of the method used. If planted with a wheat drill 1 bushel per acre is found to give the heaviest yields and the best quality of hay throughout the semiarid region. In extremely dry sections one-half bushel will be sufficient. In the more humid regions 2 bushels per acre prove more satisfactory, and if the seeds are evenly distributed more than this quantity is not necessary except, perhaps, where irrigation is practiced.

In drill rows 3 or 3½ feet apart about 15 to 20 pounds per acre will give a stand sufficiently thick to give hay of a most excellent quality. Thick plantings make a uniform growth and produce crops that are uniform in maturing. Such conditions are conducive to harvesting the greater part of the crop at the proper stage, thereby securing hay of the best quality. Thinner plantings are not recommended except in very dry sections, as they do not give the best quality or yields of hay, nor are they as easily handled. In doubling the number of plants on a given piece of land one doubles the number of leaves and thereby increases the quality of his hay by increasing the digestible portion and decreasing the percentage of fiber. As much as 25 or 30 pounds per acre would not be too thick for the more humid sections. The thickest seeding that can be grown without decreasing the yield undoubtedly approaches nearest the ideal crop.

CULTIVATING.

While sorghum will grow and give good yields with little or no cultivation, this is by no means the most profitable or the most economical method of producing a crop. Judicious cultivation has repeatedly been known to increase materially the yield of forage per acre. In rows it is generally conceded that cultivation is necessary, but such a crop seldom gets the proper cultivation at the right time. The first cultivation can be given with a spike-tooth harrow. As soon as possible after harrowing it should be cultivated deeply, and later in the season it should be given two additional shallower cultivations. This will insure a good crop. When broadcasted or planted in close drill rows at least one harrowing and two later cultivations with a weeder are necessary for the heaviest crops of hay. This can be done the last time when the crop is 2 or 2½ feet high and will put the surface soil in perfect condition to retain all moisture for the use of the growing sorghum.

SORGHUM-COWPEA MIXTURES.

Not much work has been done with sorghum-cowpea mixtures as a crop, but wherever grown they have shown considerable promise. Some work of this kind at Brownsville, San Antonio, Chillicothe, and Amarillo, Tex., has presented certain features concerning the growth of mixtures which may well be called to the attention of sorghum growers. These points deal with the varieties and proportions of each used in mixtures, the quantity to plant per acre, and the manner of planting.

Sorghum-cowpea mixtures, if proportioned and planted properly, perhaps do not give as great forage yields as sorghum alone, but the quality of the hay is superior, since the legume supplies protein, making the forage almost a complete ration. This hay, if cured properly, is relished by all live stock. No doubt the bad effect the sorghums have on land will be materially lessened by growing this crop in mixtures with legumes.

Probably the most commonly grown mixture is Amber sorghum and Whippoorwill cowpeas, although results obtained thus far at the places mentioned above indicate that Sumac sorghum and some vigorous cowpea, such as the Brabham or Unknown, will give the best crops of forage, especially in the more humid sections. It appears also that the Sumac, or some variety that does not make too quick growth, is preferable in the drier sections.

Mixtures of six parts by measure of Whippoorwill cowpeas to one of Amber sorghum have given the desired proportionate stands of cowpeas and sorghum. The basis of any mixture should depend on the proportionate sizes of the seeds to be mixed, and since the Sumac seed is smaller than that of Amber, a mixture using this variety will require a somewhat greater proportion of cowpeas.

In growing mixtures the rate of seeding has as much to do with the quantity and quality of the crop as when sorghum alone is grown. Results have shown that without irrigation from 1 to 1½ bushels of the mixture per acre, when broadcasted, will give an excellent crop, while for irrigated lands 3 bushels per acre is not considered too much. When seeded in rows, from 8 to 30 pounds is recommended, depending on the dryness of the region. The seed of the mixture should be evenly distributed, and this can best be done by drilling the seeds of the two crops separately or by thoroughly mixing the seeds before putting them into the drill. Any agitation after the seed has been put in the drill will cause the smaller seed to sink to the bottom.

Undoubtedly the most satisfactory way to grow these mixtures, especially where the moisture supply is abundant, is in close drills or broadcast. This seems to produce a more erect growth of the legume, and consequently the harvesting is much more satisfactory. In wide-spaced rows there is a tendency for the sorghum to grow too coarse and for the legume to spread too much, and only where the supply of moisture is limited is planting in this manner recommended.

Broadcasted or close-drilled mixtures can be harvested quite satisfactorily with the mower and no doubt to advantage with a wheat binder. If grown in rows and harvested with a mower the hay is difficult to handle on account of its coarseness. The least difficulty is experienced in harvesting when the plants are evenly distributed in the row.

WHEN AND HOW TO HARVEST SORGHUM.

The sorghums should be harvested when in the late milk stage. If cut at this time, the forage is more palatable and will give the greatest feeding value per acre. Large fields can be cut in the same order in which they were planted, which will in most cases allow harvesting at the proper time. Crops that mature evenly can be harvested much more satisfactorily than fields that mature irregularly. Where a seed crop is desired, cutting can be delayed until the seed is well in the dough stage without materially decreasing the feeding value of the forage. Cutting should not, however, be delayed so long except for the sake of a seed crop. In case the field to be harvested does not reach maturity, which is sometimes the case in dry regions, it is best to allow as much growth as possible before cutting. In the more humid regions the time of harvesting should depend somewhat upon the weather conditions, early cutting being preferable when weather conditions are favorable.

If planted in rows, the sorghums are usually cut with a corn harvester and put in shocks of 12 to 60 bundles each. When planted broadcast or in close drill rows, the ordinary wheat binder can be operated quite successfully. These bundles can likewise be put in shocks, as from a corn harvester, and left to cure. Frequently broadcasted or close-drilled seedings are cut with a mower.

CURING SORGHUM HAY.

Probably more than half the sorghum grown for hay is improperly cured. Inasmuch as curing greatly affects the quality and palatability of the hay and the ease with which it can be marketed, it is a very important factor to be considered.

Most frequently in curing too much sunlight is given, which darkens and injures the hay, allowing much of its flavor and aroma to escape, and aside from making hay less palatable also burns and destroys much of its feeding value. Mown sorghum should therefore never be left in the swath to cure, but should be raked into windrows and cocks as soon as thoroughly wilted, which is usually about one day after cutting. These cocks, as left by the rake, should be forked around the edges and left untouched to settle and cure. The curing usually takes about three or four weeks of sunshiny weather, and by that time it will have cured into bright, sweet, well-flavored hay. In humid regions these cocks should be made quite small, so that in case of rainfall they will dry out without molding. In some regions where the rainfall is abundant it is customary to leave the hay in the swath so as to hasten curing and thus avoid getting it wet, but it is doubtful whether curing is hastened sufficiently in this manner to justify the loss by burning. Even in such regions it might in most cases be more profitable to cure in small cocks, for only in this manner can the best grade of hay be secured. In the drier regions these cocks may safely be made quite large.

In curing bundled sorghum the same principles must be observed by putting it immediately into shocks varying in size from 12 to 60 bundles, depending on the dryness of the region. Preferably, these shocks should be large and the hay will be bright, sweet, and palatable.

In the more humid regions sorghum hay should be stacked or stored immediately after it is thoroughly cured. This is not so urgent in the drier regions, because the hay is less likely to be damaged by rain; however, unless it is to be fed early from the field it should be hauled and stored as soon after curing as possible.

STORING AND FEEDING SORGHUM.

In storing it is necessary to haul the hay to the barn or to a convenient stacking place. This hauling necessitates considerable labor, as sorghum hay is always more or less difficult to handle. The use of a low-wheeled wagon truck with a broad platform or hay frame will greatly save the labor of loading, whether the hay is loose, baled, or bundled. If bundled it will have pressed together sufficiently in curing to occupy little more space than baled hay, and it can therefore be stored under shelter to advantage or in fairly good shape by stacking in the open. If it is desirable to store the hay loose it can best be stacked in the same manner. Stacks, whether made of loose or bundled hay, should be made long and narrow, and in line with the prevailing wind, so as to avoid their being blown over or decapped. Baled hay should be put under shelter or well capped with loose hay.

If properly cured, so as to retain its flavor and aroma, sorghum hay is one of the best kinds of roughage grown on the farm, and all live stock eat it greedily. The large amount of sugar contained in the stems makes it more palatable, and results from feeding it are very satisfactory. It is the cheapest and perhaps the best roughage to be had throughout the Southern States, and in sections where little or no roughage is fed through the winter months it will be found a most excellent additional feed. Horses and cattle can be kept through the winter in good condition on sorghum hay with very little additional grain. If in bundles, one bundle at a feed will be sufficient for either a horse or a cow, and if loose or baled, about 12 to 15 pounds will be required. When feeding loose hay from the stack the use of a hay knife for cutting will be found the most satisfactory way of getting out the hay, and it should always be taken from the end of the stack least exposed to the weather.

MARKETING THE CROP.

Inasmuch as loose hay can not be delivered to other than the local markets, it must be baled. This can be done at harvest time or at any convenient time later if the hay is properly stacked. When baled, all sorghum grown broadcast or in close drills, if sown sufficiently thick not to be coarse, can be disposed of advantageously, as this hay finds a ready market in carload lots at a price somewhat lower than that of prairie hay. The tonnage per acre is great, and it is therefore a very profitable crop. The fineness of the hay and the manner in which it has been cured has much to do with its finding a ready sale.

Bundled sorghum at the present time has no market other than in the locality where it is grown. While it will never enter the general market, it is feasible and proper that sorghum in this form should find sale with individuals who feed considerable quantities of hay, for the reason that it can be supplied to near-by markets much more cheaply than when baled on account of the fact that the cost of preparing it for market is not so great. If planted thickly in the row the quality is about the same.

As for shipping, bundled sorghum hay would undoubtedly take the same rate as baled hay, provided the shipper guarantees the minimum carload, which is about 16,000 pounds, or 8 tons. This weight of bundled sorghum hay can easily be placed in a car provided the weather conditions are right. It is definitely known that 10 tons of bundled kafir, averaging 14½ pounds per bundle, can be placed in a car without difficulty in favorable weather. During the past two seasons sorghum has been a very profitable hay crop throughout the region where it is grown.

GROWING PURE AND IMPROVED SEED OF SORGHUM.

There is at present, and probably will remain for some time, a heavy demand for pure and improved sorghum seed. This demand can be supplied only by farmers and growers in the semiarid region, where the midge is not a pest. To produce the best crop and to sell to the best advantage the seed should by all means be pure, and after this the degree to which it has been bred marks its value. Therefore, in attempting to grow sorghum seed for the market, the farmer should first obtain pure seed. Obtaining such, he should set aside about an acre of land to be used as a seed patch. This seed patch should be apart from the regular field and separated as far as possible from any other variety of sorghum. Unless the grower is able to isolate each variety he should not attempt to grow more than one. This seed patch should be planted each year by the head-to-row method, and at about the time of maturity selections should be made for seed to plant the seed patch the succeeding year. Selections should be made only from the best row, and in picking an individual the conditions under which it has produced its good characters should be considered. Leafiness, sweetness, and juiciness of stem, as well as the forage yield, are important factors. In making selections care should be taken that only plants characteristic of the variety are chosen. In case there is any impurity in the field it should be carefully rogued from the patch, and this should be done as soon as the heads have emerged and before they have scattered pollen. Seed for the general field will be produced each year by the seed patch, while market seed can be secured from the general field.

Sorghums grown for seed should always be planted in rows 3 feet apart, with plants from 4 to 6 inches apart in the drill. This will insure a heavier seed crop and strong, fully developed seeds. Plantings for seed should be made early in the season, as late plantings often produce poor seed crops. If sufficient care is taken to produce only good, strong, pure seed, no difficulty will be experienced in marketing it at a price sufficiently great to more than justify the care and extra labor.

SUMMARY.

There are seven important varieties or varietal groups of saccharine sorghum, namely, Sumac, Amber, Orange, Planter, Gooseneck, Honey, and Sapling.

The best variety for a given region is not necessarily the one that gives the heaviest forage yield, but the one that gives the greatest quantity of forage of the best quality. The sorghum region is approximately divided into two sections by the central line of Kansas and Missouri. The Sumac and the Amber are considered the best types for the southern and northern regions, respectively.

The four most important factors tending to retard the extension of the growth of sorghums are scarcity of seed, inferior grades of seed, bad effect on land, and failure to harvest and cure the hay properly.

The best yields of forage depend largely on good seed and a well-prepared seed bed, but perhaps to a greater extent on the time, method, and rate of seeding. The thickest seeding that can be grown without decreasing the yield undoubtedly approaches nearest the ideal crop.

Sorghum-cowpea mixtures may not give as great yields as sorghum alone, but the quality of the hay is superior. Sumac sorghum and some vigorous-growing cowpea, such as the Brabham or Unknown, seem to give the best crops. Six parts of cowpeas to one of sorghum will give about the desired proportionate stand in the mixtures. Without irrigation, from 1 to 1½ bushels of seed per acre when broadcasted will give an excellent crop, while for irrigated lands 3 bushels is not too much. When seeded in rows, from 8 to 30 pounds to the acre is recommended.

For the best quality and quantity of forage, sorghum should be harvested when the seeds are in the late milk stage. If planted in rows, it can be cut with a corn harvester; if in close drills or broadcast, either a binder or a mower can be used.

The hay should be cured by putting it into shocks or cocks immediately after it has been harvested. This gives a bright, sweet, palatable feed. Sorghum hay should be stored as soon as possible after it has thoroughly cured.

A low-wheeled wagon truck with a broad platform will be found a great labor saver in hauling the crop. Well-cured sorghum hay is an excellent winter feed, and horses and cattle fed on it with a small additional grain ration can be kept in excellent condition.

Baled sorghum hay finds a ready market in carload lots at a price somewhat lower than that of prairie hay. Although bundled sorghum has no market at the present time, it might readily be disposed of to individual feeders. It takes the same shipping rate as baled hay, and the minimum tonnage can be placed in a car. If planted thickly in rows, the fineness of the stems will be materially increased and the hay is not less desirable than when baled. It can be prepared for market more cheaply than the baled hay.

Good seed crops can be secured with safety only in the less humid regions not infested with midge. The business of growing seed in this region should become very profitable. With sufficient care to produce only good, strong, pure seed, no difficulty will be experienced in marketing it at a price sufficiently great to more than justify the care and extra labor.

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FARMERS' BULLETIN 459.

HOUSE FLIES.

BY

L. O. HOWARD,
Chief of the Bureau of Entomology.

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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., May 23, 1911.

Sir: I have the honor to transmit for publication a paper dealing with the subject of the house fly or typhoid fly. Previous publications of this department concerning this insect have been in circular form, but it is desired to make this information more widely available through the medium of a Farmers' Bulletin. With this intention this manuscript has been prepared, being modified and amplified from Circular No. 71 of this bureau, and I respectfully recommend its publication as a Farmers' Bulletin.

Respectfully,
L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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HOUSE FLIES.

INTRODUCTION.

There are several species of flies which are commonly found in houses, although but one of these should be called the house fly proper. This is the *Musca domestica* L. (fig. 1) and is a medium-sized, grayish fly, with its mouth parts spread out at the tip for sucking up liquid substances. It is found in nearly all parts of the world. On account of the conformation of its mouth parts, the house fly can not bite, yet no impression is stronger in the minds of most people than that this insect does occasionally bite. This impression is due to the frequent occurrence in houses of another fly (*Stomoxys calcitrans* L.) (fig. 2), which is called the stable fly, and which, while closely resembling the house fly (so closely, in fact, as to deceive anyone but an entomologist), differs from it in the important particular that its mouth parts are formed for piercing the skin. It is perhaps second in point of abundance to the house fly in most portions of the Northeastern States. It breeds in horse manure, cow manure, and in warm decaying vegetation like old straw and grass heaps.

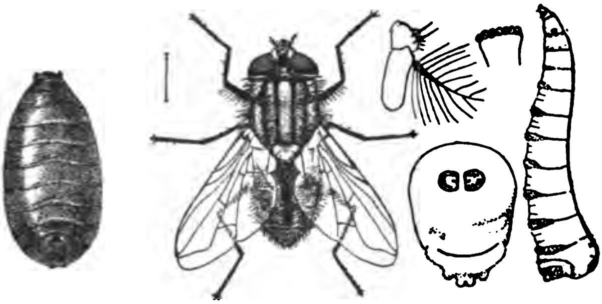

FIG. 1.—The common house fly (*Musca domestica*): Puparium at left; adult next; larva and enlarged parts at right. All enlarged. (Author's illustration.)

A third species, commonly called the cluster fly (*Pollenia rudis* Fab.), is a very frequent visitant of houses, particularly in the spring and fall. This fly is somewhat larger than the house fly, with a dark-colored, smooth abdomen and a sprinkling of yellowish hairs. It is not so active as the house fly and, particularly in the fall, is very sluggish. At such times it may be picked up readily and is very subject to the attacks of a fungous disease which causes it to die upon window panes, surrounded by a whitish efflorescence. Occasionally this fly occurs in houses in such numbers as to cause great annoyance, but such occurrences are comparatively rare. It is said in its earlier stages to be parasitic on certain angleworms.

A fourth species is another stable fly, known as *Muscina stabulans* Fall. (fig. 3), a form which almost exactly resembles the house fly in general appearance, and which does not bite as does the biting stable fly. It breeds in decaying vegetable matter and in excrement.

Several species of metallic greenish or bluish flies are also occasionally found in houses, the most abundant of which is the so-called blue-bottle fly (*Calliphora erythrocephala* Meig.). This insect is also called the blow-fly or meat-fly and breeds in decaying animal material. A smaller species, which may be called the small blue-bottle fly, is *Phormia terrænovæ* Desv. (fig. 4); and a third, which is green or blue in color and a trifle smaller than the large blue-bottle, is *Lucilia cæsar* L. (fig. 5).

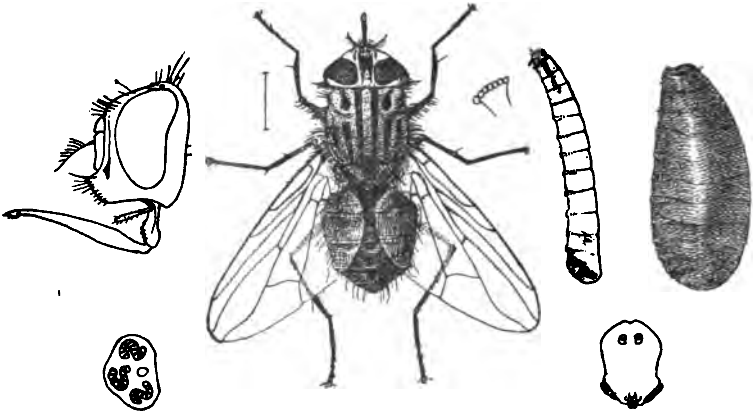

Fig. 2.—The stable fly or biting house fly (*Stomoxys calcitrans*): Adult, larva, puparium, and details. All enlarged. (Author's illustration.)

There is still another species, smaller than any of those so far mentioned, which is known to entomologists as *Homalomyia canicularis* L., sometimes called the small house fly. A related species, *H. brevis* Rond., is shown in figure 6. *H. canicularis* is distinguished from the ordinary house fly by its paler and more pointed body and conical shape. The male, which is much commoner than the female, has large pale patches at the base of the abdomen, which are translucent when the fly is seen on a window pane. It is this species that is largely responsible for the prevalent idea that flies grow after gaining wings. Most people think that these little Homalomyias are the young of the larger flies, which, of course, is distinctly not the case. They breed in decaying vegetable material, in the excreta of animals, and in dead insects.

Still another fly, and this one is still smaller, is a jet-black species known as the window fly (*Scenopinus fenestralis* L.), which in fact has become more abundant of later years. Its larva is a white, very slender, almost thread-like creature, and is found in cracks of the floor in buildings, where it feeds on other small insects.

In the autumn, when fruit appears on the sideboard, many specimens of a small fruit-fly (*Drosophila ampelophila* Loew) (fig. 7) make their appearance, attracted by the odor of overripe fruit.

A small, slender fly is not infrequently seen in houses, especially upon window panes. This is *Sepsis violacea* Meig., shown enlarged in figure 8.

All of these species, however, are greatly dwarfed in numbers by the common house fly. In 1900 the writer made collections of the flies in dining rooms in different parts of the country, and out of a total of 23,087 flies 22,808 were *Musca domestica*—that is, 98.8 per cent of the whole number captured. The remainder, consisting of 1.2 per cent of the whole, comprised various species, including those mentioned above.

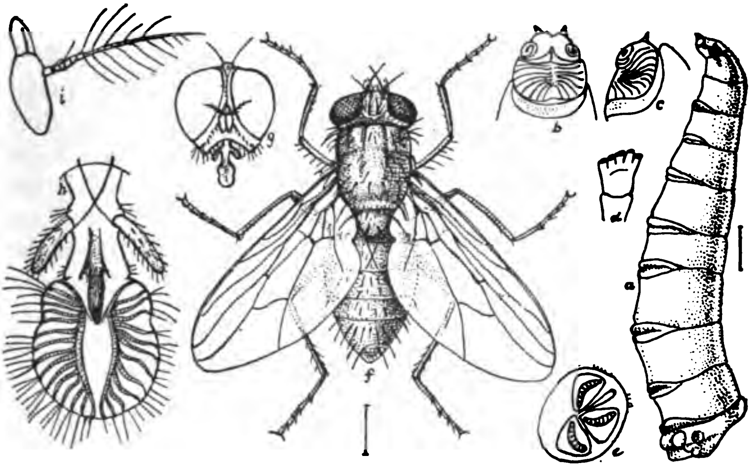

Fig. 3.—A stable fly (*Muscina stabulans*): Adult, larva, and details. All enlarged. (Author's illustration.)

LIFE HISTORY OF THE TRUE HOUSE FLY.

Musca domestica commonly lays its eggs upon horse manure. This substance seems to be its favorite larval food. It will oviposit on cow manure, but we have not been able to rear it in this substance. It will also breed in human excrement, and from this habit it becomes very dangerous to the health of human beings, carrying, as it does, the germs of intestinal diseases such as typhoid fever and cholera from excreta to food supplies. It will also lay its eggs upon other decaying vegetable and animal material, but of the flies that infest dwelling houses, both in cities and on farms, a vast proportion comes from horse manure.

It often happens, however, that this fly is very abundant in localities where there is little or no horse manure, and in such cases it will be found breeding in other manure or in slops or fermenting vegetable material, such as spent hops, or bran, or ensilage.

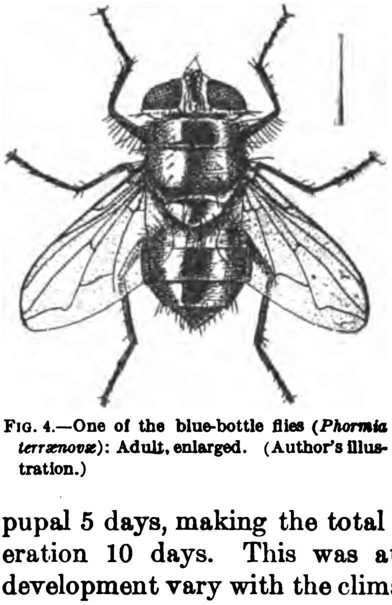
FIG. 4.—One of the blue-bottle flies (*Phormia terrænovæ*): Adult, enlarged. (Author's illustration.)

At Salem, Mass., Packard states that he reared a generation in 14 days in horse manure. The duration of the egg state was 24 hours, the larval state from 5 to 7 days, and the pupal state from 5 to 7 days. At Washington the writer has found in midsummer that each female lays at one time about 120 eggs, which hatch in 8 hours, the larval period lasting 5 days and the pupal 5 days, making the total time for the development of the generation 10 days. This was at the end of June. The periods of development vary with the climate and with the season, and the insect hibernates in the puparium condition in manure or at the surface of the ground under a manure heap. It also hibernates in houses as adult, hiding in crevices.

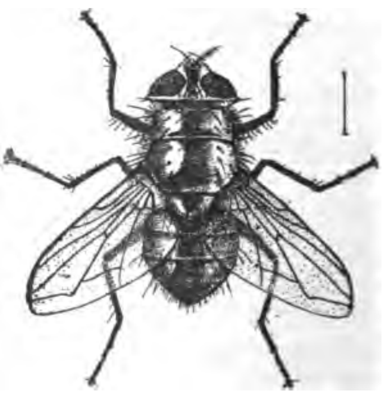
FIG. 5.—The green-bottle fly (*Lucilia cæsar*): Adult, enlarged. (Author's illustration.)

The Washington observations indicate that the larvæ molt twice, and that there are thus three distinct larval stages.

The periods of development were found to be about as follows: Egg from deposition to hatching, one-third of a day; hatching of larva to first molt, 1 day; first to second molt, 1 day; second molt to pupation, 3 days; pupation to issuing of adult, 5 days; total life round, approximately 10 days. There is thus abundance of time for the development of 12 or 13 generations in the climate of Washington every summer.

The number of eggs laid by an individual fly at one time is undoubtedly large, averaging about 120, and a single female may lay 4 such batches, so that the enormous numbers in which the insects occur is thus plainly accounted for, especially when the abundance and universal occurrence of appropriate larval food is considered. In order to ascertain the numbers in which house-fly larvæ occur in horse-manure piles, a quarter of a pound of rather well-infested horse manure was taken on August 9, and in it were counted 160 larvæ and 146 puparia. This would make about 1,200 house flies to the pound of manure. This, however, can not be taken as an average, since no larvæ are found in perhaps the greater part of ordinary horse-manure piles. Neither, however, does it show the limit of what can be found, since about 200 puparia were found in less than 1 cubic inch of manure taken from a spot 2 inches below the surface of the pile where the larvæ had congregated in immense numbers. The different stages of the insect are well illustrated in figure 1 and need no description.

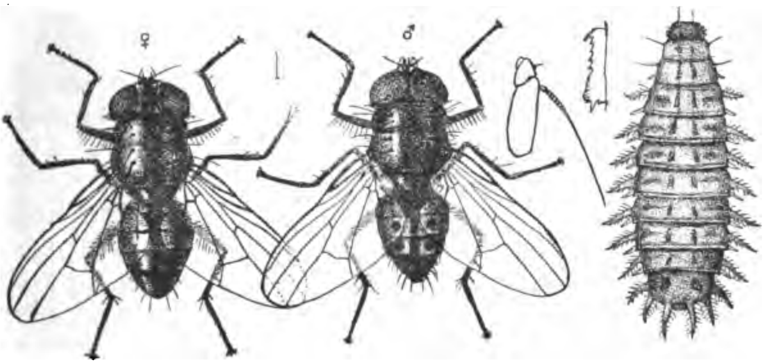

FIG. 6.—The little house fly (*Homalomyia brevis*): Female at left; male next, with enlarged antenna; larva at right. All enlarged. (Author's illustration.)

CARRIAGE OF DISEASE.

In army camps, in mining camps, and in great public works, bringing together large numbers of men for a longer or shorter time, there is seldom the proper care of excreta, and the carriage of typhoid germs from the latrines and privies to food by flies is common and often results in epidemics of typhoid fever.

And such carriage of typhoid by flies is by no means confined to these great temporary camps. In farmhouses in small communities and even in the badly cared-for portions of large cities typhoid germs are carried from excrement to food by flies, and the proper supervision and treatment of the breeding places of the house fly become most important elements in the prevention of typhoid.

In the same way other intestinal germ diseases are carried by flies. The Asiatic cholera, dysentery, and infantile diarrhea are all so carried.

Nor are the disease-bearing possibilities of the house fly limited to intestinal germ diseases. There is strong circumstantial evidence that tuberculosis, anthrax, yaws, ophthalmia, smallpox, tropical sore, and parasitic worms may be and are so carried. Actual laboratory proof exists in the cases of a number of these diseases, and where lacking is replaced by circumstantial evidence amounting almost to certainty.

REMEDIES AND PREVENTIVES.

A careful screening of windows and doors during the summer months, with the supplementary use of sticky fly papers, is a preventive measure against house flies known to everyone, and there seems to be little hope in the near future of much relief by doing away with the breeding places. A single stable in which a horse is kept will supply house flies for an extended neighborhood. People living in agricultural communities will probably never be rid of the pest, but in cities, with better methods of disposal of garbage and with the lessening of the number of horses and horse stables consequent upon electric street railways, bicycles, and automobiles, the time may come, and before very long, when window screens may be discarded. The prompt gathering of horse manure, which may be variously treated or kept in a specially prepared receptacle, would greatly abate the fly nuisance, and city ordinances compelling horse owners to follow some such course are desirable. Absolute cleanliness, even under existing circumstances, will always result in a diminution of the numbers of the house fly, and, in fact, most household insects are less attracted to the premises of what is known as the old-fashioned housekeeper than to those of the other kind.

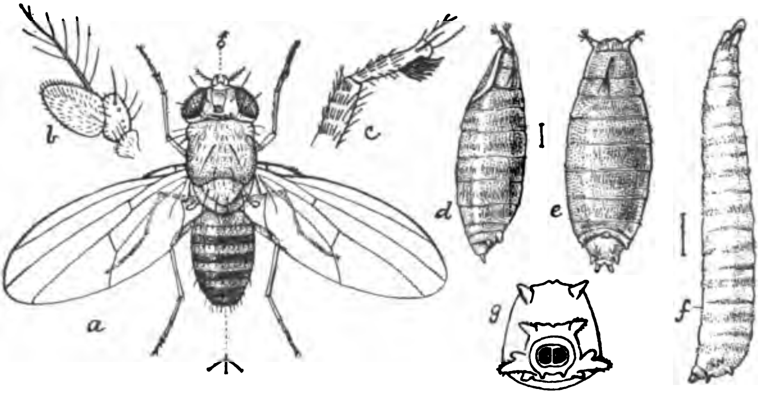

FIG. 7.—The fruit fly (*Drosophila ampelophila*): *a*, Adult; *b*, antenna of same; *c*, base of tibia and first tarsal joint of same; *d*, puparium, side view; *e*, puparium from above; *f*, full-grown larva; *g*, anal spiracles of same. All enlarged. (Author's illustration.)

Not only must all horse stables be cared for, but chicken yards, piggeries, and garbage receptacles as well, and absolutely sanitary privies are prime necessities. Directions for building and caring for such privies will be found in Farmers' Bulletin No. 463. The dry-earth treatment of privy vaults is unsatisfactory. Kerosene should be used.

During the summer of 1897 a series of experiments was carried out with the intention of showing whether it would be possible to treat a manure pile in such a way as to stop the breeding of flies. The writer's experience with the use of air-slaked lime on cow manure to prevent the breeding of the horn fly (*Hæmatobia serrata* Rob.-Desv.) suggested experimentation with different lime compounds. It was found to be perfectly impracticable to use air-slaked lime, land plaster, or gas lime with good results. Few or no larvæ were killed by a thorough mixing of the manure with any of these three substances. Chlorid of lime, however, was found to be an excellent maggot killer. Where 1 pound of chlorid of lime was mixed with 8 quarts of horse manure, 90 per cent of the maggots were killed in less than 24 hours. At the rate of one-fourth of a pound of chlorid of lime to 8 quarts of manure, however, the substance was found not to be sufficiently strong. Chlorid of lime, though cheap in Europe, costs at least 3½ cents a pound in large quantities in this country, so that the frequent treatment of a large manure pile with this substance would be out of the question in actual practice.

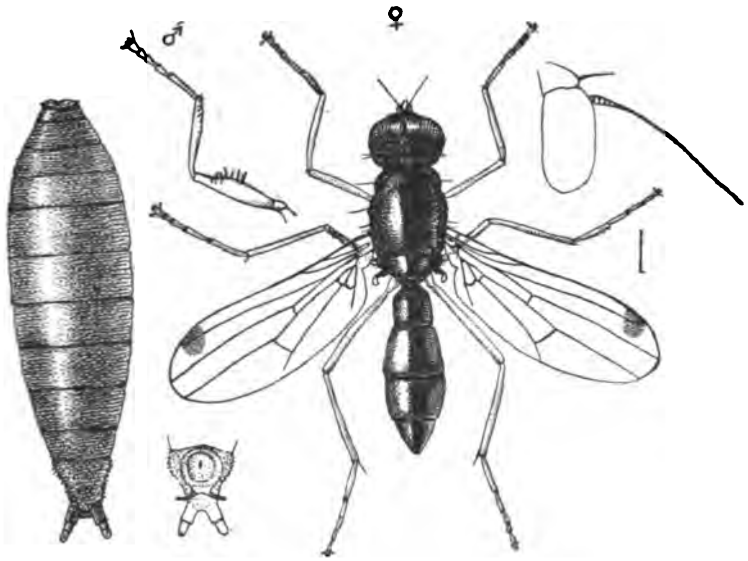

FIG. 8.—The dung fly (*Sepsis violacea*): Adult, puparium, and details. All enlarged. (Author's illustration.)

Experiments were therefore carried on with kerosene. It was found that 8 quarts of fresh horse manure sprayed with 1 pint of kerosene, which was afterwards washed down with 1 quart of water, was thoroughly rid of living maggots. Every individual was killed by the treatment. This experiment and others of a similar nature on a small scale were so satisfactory that it was considered at the close of the season that a practical conclusion had been reached, and that it was perfectly possible to treat any manure pile economically and in such a way as to prevent the breeding of flies.

Practical work in the summer of 1898, however, demonstrated that this was simply another case where an experiment on a small scale has failed to develop points which in practical work would vitiate the results.

The stable of the United States Department of Agriculture, in which about 12 horses were kept, was situated about 100 yards behind the main building of the department and about 90 yards from the building in which the Bureau of Entomology is situated. This stable was always very carefully kept. The manure was thoroughly swept up every morning, carried outside of the stable, and deposited in a pile behind the building. This pile, after accumulating for a week or 10 days, or sometimes 2 weeks, was carried off by the gardeners and spread upon distant portions of the grounds. At all times in the summer this manure pile swarmed with the maggots of the house fly. It is safe to say that on an average many thousands of perfect flies issued from it every day, and that at least a large share of the flies which constantly bothered the employees in the two buildings mentioned came from this source.

On the basis of the experiments of 1897, an attempt was made, beginning early in April, 1898, to prevent the breeding of house flies about the department by the treatment of this manure pile with kerosene. The attempt was begun early in April and was carried on for some weeks. While undoubtedly hundreds of thousands of flies were destroyed in the course of this work, it was found by the end of May that it was far from perfect, since if used at an economical rate the kerosene could not be made to penetrate throughout the whole pile of manure, even when copiously washed down with water. A considerable proportion of house-fly larvæ escaped injury from this treatment, which at the same time was found, even at an economical cost, to be laborious, and such a measure, in fact, as almost no one could be induced to adopt.

There remained, however, another measure which had been suggested by the writer in an article on the house fly published in 1895, namely, the preparation of an especial receptacle for the manure; and this was very readily accomplished. A closet 6 by 8 feet had been built in the corner of the stable nearest the manure pile. It had a door opening into the stable proper, and also a window. A door was built in the outside wall of this closet, and the stablemen were directed to place no more manure outside the building; in other words, to abolish the outside manure pile, and in the future to throw all of the manure collected each morning into this closet, the window of which in the meantime had been furnished with a wire screen. The preparations were completed by the middle of June, and a barrel of chlorid of lime was put in the corner of the closet. Since that time every morning the manure of the stable is thrown into the closet, and a small shovelful of chlorid of lime is scattered over it. At the expiration of 10 days or 2 weeks the gardeners open the outside door, shovel the manure into a cart, and carry if off to be thrown upon the grounds.

Judging from actual examination of the manure pile, the measure is eminently successful. Very few flies are breeding in the product of the stable which formerly gave birth to many thousands daily. After this measure had been carried on for two weeks, employees of the department who had no knowledge of the work that was going on were asked whether they had noticed any diminution in the number of flies in their offices. Persons in all of the offices on the first floor of the two buildings were asked this question. In every office except one the answer was that a marked decrease had been noticed, so that the work must be considered to have been successful.

The account of this remedial work has been given with some detail, since it shows so plainly that care and cleanliness combined with such an arrangement as that described will in an individual stable measurably affect the fly nuisance in neighboring buildings

With the combined efforts of the persons owning stables in a given community, much more effective results can undoubtedly be gained.

In the consideration of these measures we have not touched upon the remedies for house flies breeding in human excrement. On account of the danger of the carriage of typhoid fever, the dropping of human excrement in the open in cities or towns, either on vacant lots or in dark alleyways, should be made a misdemeanor, and the same care should be taken by the sanitary authorities to remove or cover up such depositions as is taken in the removal of the bodies of dead animals. The box privy is always a nuisance from many points of view, and is undoubtedly dangerous as a breeder of flies which may carry the germs of intestinal disease. No box privies should be permitted to exist unless they are conducted on the kerosene principle. With a proper vault or other receptacle, closed except from above, and a free use of kerosene and water, the breeding of house flies can be prevented.

A Parisian journal, the Matin, during the winter of 1905–6, established a prize of 10,000 francs for the best essay on the destruction of the house fly. The jury of competent scientific men awarded the prize to the author of a memoir in which it was proposed to use residuum oil in the destruction of the eggs and larvæ of the fly. This oil is to be used in privies and cesspools. Two liters per superficial meter of the pit is mixed with water, stirred with a stick of wood, and then thrown into the receptacle. It is said to form a covering of oil which kills all the larvæ, preventing the entrance of flies into the pit and, at the same time, the hatching of eggs. It makes a protective covering for the excrement, and this is said to hasten the development of anærobic bacteria as in a true septic pit, leading in this way to the rapid liquefaction of solid matters and rendering them much more unfit for the development of other bacteria. For manure it is recommended to mix this residuum oil with earth, with lime, and with phosphates, and to spread it at different times, in the spring by preference, upon the manure of farms and stables and so on.

There seems to be a definite period of perhaps 10 days between the issuing of the adult flies and the laying of eggs. During this period, and especially in the early spring, it becomes important to trap as many flies as possible. With this end in view, Prof. C. F Hodge, of Clark University, Worcester, Mass., has devised certain flytraps which he attaches to garbage cans and to screened stable windows, and which he places in the neighborhood of possible fly-breeding places.

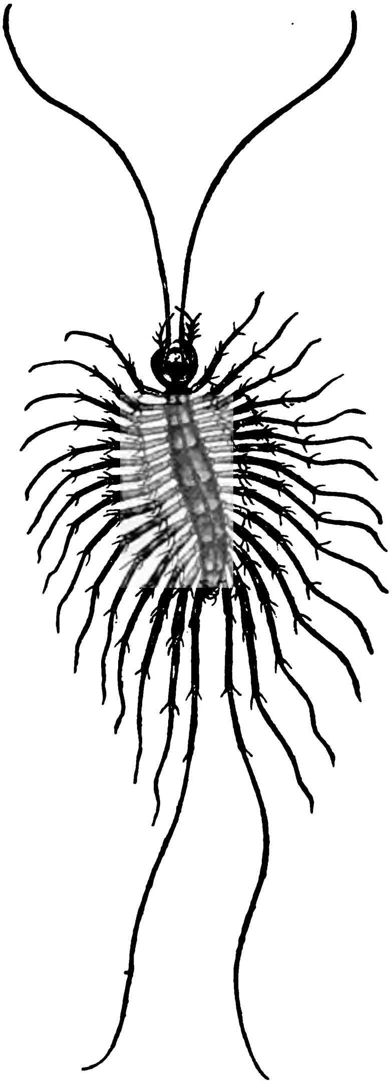

FIG. 9 —The house centipede (*Scutigera forceps*). Adult natural size (After Marlatt.)

So many cheap flytraps are on the market that it is unnecessary and undesirable to specify any particular kind. Many of them are good.

NATURAL ENEMIES.

The house fly has a number of natural enemies. The common house centipede (fig. 9) destroys it in considerable numbers, there is a small reddish mite which frequently covers its body and gradually destroys it, it is subject to the attacks of hymenopterous parasites in its larval condition, and it is destroyed by predatory beetles at the same time.

The most effective enemy, however, is a fungous disease known as *Empusa muscæ*, which carries off flies in large numbers, particularly toward the close of the season. The epidemic ceases in December, and although many thousands are killed by it, the remarkable rapidity of development in the early summer months soon more than replaces the thousands thus destroyed.

WHAT CITIES AND TOWNS CAN DO.

It would appear, from what we know of the life history of the common house fly and from what remedial experimentation has already been carried on, that it is perfectly feasible for cities and towns to reduce the numbers of these annoying and dangerous insects so greatly as to render them of comparatively slight account. The health departments of most of our cities have the authority to abate nuisances dangerous to health, and it is easy for the health authorities of any city to formulate rules concerning the construction and care of stables and the keeping and disposal of manure which, if enforced, will do away with the house-fly nuisance. Such a series of rules was formulated in the spring of 1906 by the Health Department of the city of Asheville, N. C., and an effort is being made during this summer to see that they are enforced. On the 3d of May, 1906, the Health Department of the District of Columbia also issued a series of orders of this nature, on the authority of the Commissioners of the District, and these orders, which may well serve as a model to other communities desiring to undertake similar measures, may be briefly condensed as follows:

All stalls in which animals are kept shall have the surface of the ground covered with a water-tight floor. Every person occupying a building where domestic animals are kept shall maintain, in connection therewith, a bin or pit for the reception of manure, and, pending the removal from the premises of the manure from the animal or animals, shall place such manure in said bin or pit. This bin shall be so constructed as to exclude rain water, and shall in all other respects be water tight except as it may be connected with the public sewer. It shall be provided with a suitable cover and constructed so as to prevent the ingress and egress of flies. No person owning a stable shall keep any manure or permit any manure to be kept in or upon any portion of the premises other than the bin or pit described, nor shall he allow any such bin or pit to be overfilled or needlessly uncovered. Horse manure may be kept tightly rammed into well-covered barrels for the purpose of removal in such barrels. Every person keeping manure in any of the more densely populated parts of the District shall cause all such manure to be removed from the premises at least twice every week between June 1 and October 31, and at least once every week between November 1 and May 31 of the following year. No person shall remove or transport any manure over any public highway in any of the more densely populated parts of the District except in a tight vehicle which, if not inclosed, must be effectually covered with canvas, so as to prevent the manure from being dropped. No person shall deposit manure removed from the bins or pits within any of the more densely populated parts of the District without a permit from the health officer. Any person violating any of the provisions shall, upon conviction thereof, be punished by a fine of not more than $40 for each offense.

As with all such measures, the test comes with the enforcement, and these regulations have not been well enforced, owing to the extremely small corps of inspectors allowed to the Health Department, and to other more pressing work. They can be made effective, however, and it is earnestly hoped that not only Washington but other communities as well will very soon be brought to a realization of the ease of house-fly eradication and its very great desirability.

The insect we now call the "house fly" should in the future be termed the "typhoid fly," in order to call direct attention to the danger of allowing it to continue to breed unchecked.—L. O. Howard.

Issued August 30, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 460.

FRAMES AS A FACTOR IN TRUCK GROWING.

BY

W. R. BEATTIE,
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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 26, 1911.

Sir: I have the honor to transmit herewith a manuscript entitled "Frames as a Factor in Truck Growing," by Mr. W. R. Beattie, Assistant Horticulturist, and recommend that it be published as a Farmers' Bulletin.

Respectfully,

Wm. A. Taylor,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FRAMES AS A FACTOR IN TRUCK GROWING.

INTRODUCTION.

Intensive gardening under sash or cloth covers has become one of the most popular and, in certain localities where the conditions are suitable, one of the most profitable lines of outdoor work. The trucker and the market gardener of the present day have been compelled by keen competition and a constantly increasing demand for high-grade products out of season to provide special facilities for increasing and improving the product, as well as to take advantage of every favorable natural condition.

Many localities are especially favored with an abundance of sunshine at all seasons of the year, and at the same time their climate, due to the influence of large streams or near-by bodies of water, is mild and free from extremes of temperature. In such localities it would be possible to grow lettuce, radishes, and similar crops during the entire winter without protection were it not for a few cold days and nights. A very slight covering or the application of a small amount of heat will, as a rule, carry the plants through in good condition.

During recent years the growing of winter vegetables in frames having removable covers of sash or cloth has developed greatly in the South Atlantic Coast States and in other States having mild winter conditions. In a true sense this industry is simply field culture with provision for covering the crops during temporary periods of cold weather. The present magnitude of this line of work attests its success and indicates its future possibilities. North Carolina undoubtedly has a larger acreage devoted to frame culture than any other State, but in the region about Norfolk, Va., there is also a large and growing area devoted to the work. Vegetables grown in frames are often shipped in carload lots from these large producing sections. This industry may readily be combined with regular truck farming, as it furnishes remunerative employment during the winter months. A comparatively small area is necessary for the frames, but several times that acreage of land should be available, so that the site of the frames may be changed every few years to safeguard against diseases and insect injuries.

NOTE.—A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.

TYPES OF FRAMES AND THEIR CONSTRUCTION.

CLOTH-COVERED FRAMES.

The type of frame or bed varies with the different localities and is ordinarily no more elaborate or expensive than is necessary to protect the crops. In North Carolina and South Carolina the type of frame generally used is that shown in figure 1, having for the sides two lines of 12-inch boards set on edge and held in place by means of stakes driven into the ground. The covering of cheap unbleached muslin is supported on strips of wood 1 inch thick and 2½ or 3 inches wide, which are raised in the center by being carried over the top of a stake; the ends are held down by nailing to the sides of the bed.

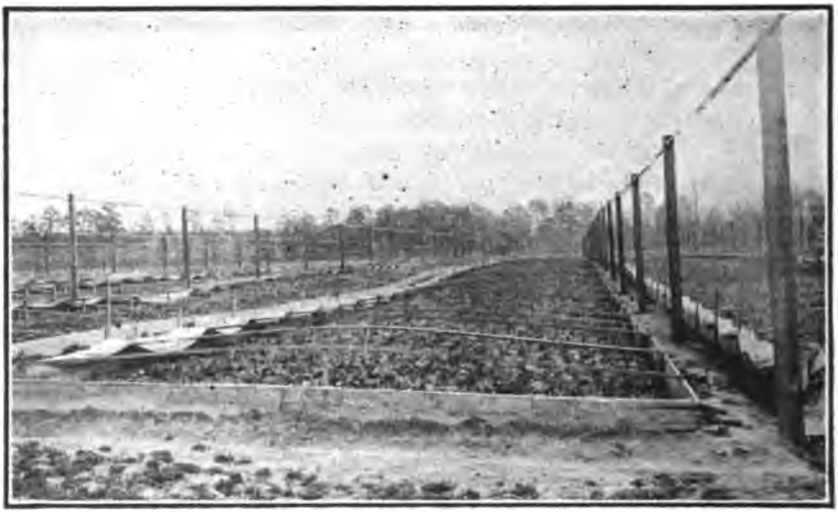

FIG. 1.—Rows of frames, showing the type used for lettuce growing in North Carolina and South Carolina. The overhead pipes are used for irrigation.

The lumber for the sides is usually 1 by 12 inches by 16 feet of the cheaper grades of cypress or a good grade of common shortleaf pine. The stakes for holding the boards in place are 1 by 3 or 2 by 3 inches in size and are driven about 1 foot into the ground. These cloth-covered beds are usually 14 feet in width, but some growers prefer them 10, 12, or 20 feet wide. The length of the frames varies greatly, but the longer ones generally run from 90 to 100 yards, depending entirely upon the space available and the evenness of the ground. The frames usually run east and west, with the cloth fastened to the north edge of the frame. Most of these frames are temporary and are taken apart and stored during the summer months.

Before placing the frames in position in the autumn the soil is plowed, thoroughly fitted, and given a liberal dressing of well-rotted stable manure and commercial fertilizers. The placing of the boards will cause some trampling of the bed, and before putting in the ends and nailing on the rafters or strips to support the cloth it is desirable to loosen the soil again by means of a harrow or cultivator. The stakes for supporting the cross strips or rafters are then driven through the center and the strips nailed in place at intervals of 4 feet. The ends are inclosed by means of 12-inch boards, and the bed is then ready for the cloth cover. The cloth is stitched, with the strips running lengthwise of the bed, into one great sheet large enough to cover the entire bed. This sheet is fastened on the north side of the frame by nailing over it plastering laths or similar strips of wood. The cloth should not be fastened to the top edge of the board but on the side, 1 or 2 inches below the top. For fastening the sheet on the south side of the frame short loops of string or cloth are attached to its edge and these are looped over nails driven into the side of the bed. In some cases brass eyelets, such as are used in tent flaps, are inserted in the edge of the cloth and hitched over nails or pins. Another method is to hem the cloth on one edge and run a ⅜-inch rope through the hem. The addition of the rope makes it comparatively easy to fasten the cloth to the side of the bed and also prevents tearing the sheet in handling. The cost of these frames, including lumber and muslin, together with the necessary facilities for supporting and fastening the cloth, will be from 35 to 50 cents a running foot for a bed 14 feet wide.

If it is necessary to refit the land while the frames are in place, the cloth is turned back into the alleys between the frames, the strips that support the cloth are removed, and a 1-horse plow is taken into the inclosure. After the land is plowed and thoroughly fitted, the strips are again put in place. As the work of cultivating the crops must all be done by hand it is essential that the soil be well prepared before planting.

SASH-COVERED FRAMES.

In the tidewater region of Virginia the frames are covered with hotbed sash. The climate of Norfolk is a little too severe for the use of cloth except for early autumn and spring crops. A number of growers in the vicinity of Norfolk handle sash-covered frames occupying as much as 3, 4, or 5 acres each season. (Fig. 2.) For the sides and ends of these frames the same class of cheap lumber as for the cloth-covered frames is used. The back or north side of the frame is usually 12 or 14 inches high, while the front or south side is about 4 inches lower to give the sash sufficient slope. The standard hotbed sash universally used for covering these frames is 3 feet in width and 6 feet in length. The usual width of the sash-covered frame is 6 feet, but a double row of sash with a ridge through the center is sometimes employed, making the bed about 12 feet wide.

This arrangement, however, does not prove as satisfactory as the common 6-foot frame. These sash-covered frames are often 300 to 500 feet in length, but the usual length is 180 feet. No strips are provided for the support or separation of the sash, as they rest on the sides of the bed and fit close together.

Two or three types of sash may be used for this purpose, but the lower-priced ones are most commonly employed. One kind of sash is so arranged that the glass may be slid into grooves, the glass abutting without the use of putty. The better grades of sash have provision for bedding the glass in putty, lapping the lights one-eighth to one-fourth of an inch and fastening them in place with glazing points or specially designed double-pointed tacks. As a rule a very cheap grade of single-strength window glass of the smaller sizes, 6 by 8 and 8 by 10 inches, is employed. It would undoubtedly prove economical in the long run to use double-strength glass of 8 by 10 or 10 by 12 inch sizes. The double-strength glass is not so easily broken in handling or by hail, and makes a heavier and more rigid sash, especially when bedded in putty. In many cases the sash do not cost more than $1.45 each, fully glazed, while a much better grade could be had for $1.60 to $2, including painting. Many of the sash are never painted, and as they are of poor material their period of usefulness is quite short, often not more than four or five years. A well-painted cypress sash, glazed with double-strength glass bedded in putty, should with proper care give 12 or 15 years of service. From

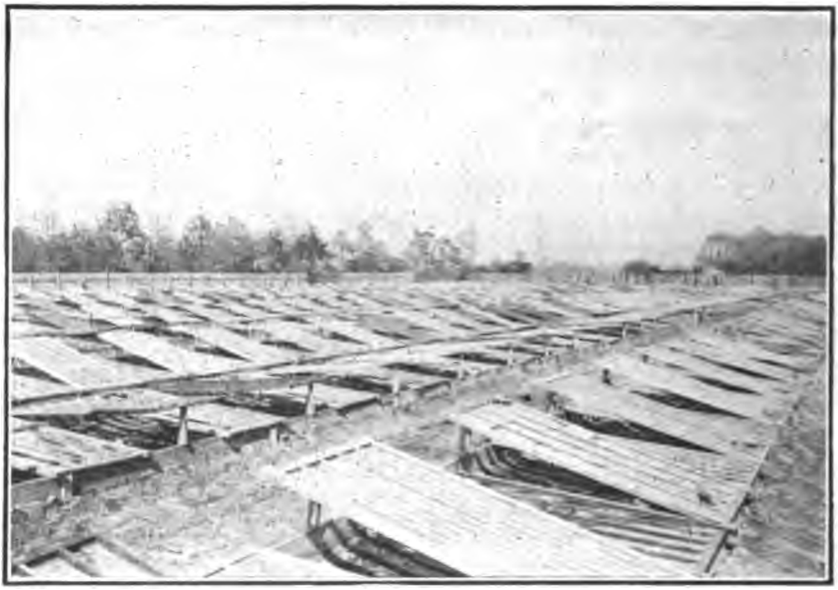

FIG. 2.—Rows of sash-covered frames.

the grower's point of view the object is generally to secure the greatest possible number of sash with the least expenditure, and as a consequence it is the cheaper grades of both sash and glass that are used.

A common practice among gardeners is to construct a shallow tank of cement, planks, or galvanized iron and to dip the sash in crude oil instead of painting them. The oil acts as a splendid preservative for the wood, but the sash so treated are dull in appearance and undoubtedly do not give as much light in the beds as those that are painted white. Most of the sash used for this purpose have six lines of glass with five sash bars. By using three lines of 10-inch glass, only two sash bars are necessary and the shading of the bed will be much less. Actual test has shown a great difference of plant growth in favor of the larger sizes of glass.

HEATED FRAMES.

Farther north, near several of the large cities, including Baltimore, Philadelphia, Cincinnati, New York, and Boston, sash-covered frames are extensively used for growing early vegetables. This work is practically the same as that found at Norfolk, except that the frames are constructed over an excavation which is filled with fermenting manure to provide heat.

Where manure-heated beds are extensively used for growing early vegetables a long, shallow pit is opened, the manure is trodden in, and 12-inch boards are fastened to stakes to form the sides. The board on the north side is raised a little higher than the one on the south side in order to form a slope for the glass. A few strips are nailed across the bed to prevent the sides from coming in by the pressure of the manure or soil that is banked on the outside, and the sash simply rest on the sides without any guide or supporting strips between them. Straw mats and board shutters are employed as a protection for the sash during cold weather.

A few of the growers around Newbern and Wilmington, N. C., provide steam boilers and install heating pipes in the frames, the heat being applied only during cold weather, when the cloth alone would not prevent injury from frost. Many of the growers have steam outfits for pumping water and simply connect the pumping boiler to lines of pipes which are fastened on the sides of the frames just below the covering. As a rule, the supply pipe is run on the north side of the frame, while the return is placed on the south side, or both flow and return may be on the north or cold side of the bed. (Fig. 3.) Another method of heating consists of laying lines of 3-inch drain tiles 6 or 8 inches below the surface of the soil so as to discharge live steam into the tiles during cold weather. These systems have proved quite satisfactory in a few places, but have not been generally adopted.

SOIL AND FERTILIZERS.

PREPARATION OF THE SOIL.

The greater portion of the work with frames is conducted on light or sandy loam soils which are naturally well drained and adapted to intensive trucking. The original soil is usually employed, but when necessary rich soil is hauled and placed in the beds. The first essential is good drainage, and if the land is not naturally well drained it should be tiled or provided with numerous open ditches to carry off the water. The surface of the soil should be graded and all depressions filled in and leveled. For best results the land should be subjected to two or three years of preparation by manuring and planting to leguminous crops.

The presence of plenty of organic matter in the soil is very important, especially where large quantities of commercial fertilizers are to be used. This organic matter may be added in the form of stable manure, but more satisfactory results will be obtained where leguminous crops are included in the preparatory treatment. For green manure nothing is better than cowpeas as a summer crop and crimson clover as a winter crop. The crimson clover should be turned under about the time it comes into full bloom in the spring, the land planted to cowpeas, and the resulting crop plowed under or mowed for hay during the month of August in ample time to prepare the land for frame work during the autumn. When heavy crops of green manure are turned under it is essential that lime be used to improve the mechanical condition and to sweeten the soil; a dressing of 1,000 pounds to the acre should be sufficient.

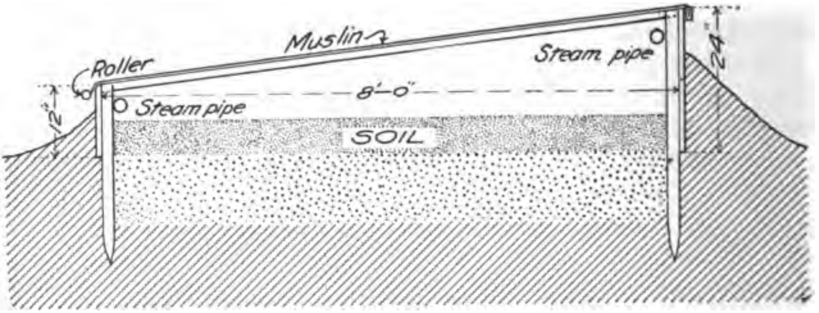

FIG. 3.—Cross section of a pipe-heated bed.

Wood ashes constitute an excellent source of both potash and lime, especially if they have resulted from the burning of hardwood. Ashes from pine and other soft woods are of little value. Much of the value of wood ashes may be lost by leaching, and while a ton of strictly fresh hardwood ashes would be sufficient to apply on an acre, as much as 5 tons of leached ashes could be used on the same area without fear of burning the plants. Where ashes are used less lime is needed, although the percentage of lime in the ash is comparatively small.

STABLE MANURE.

Large quantities of stable manure are used in growing crops in frames, sometimes as much as 30 to 60 cartloads to the acre. The manure is generally spread in a broad, flat pile to compost before it is applied to the soil on which frames are to be located. Where manure is employed for heating the beds it may afterwards be mixed with the soil for the growing of subsequent crops. In the work with frames around Norfolk, Va., the manure is placed in long, narrow piles and turned two or three times before it is used in the beds. Care should be exercised to avoid the use of manure in which there are shavings or sawdust, as these have an injurious effect upon the growth of plants. Poultry and sheep manure are excellent fertilizers for frame work, but the quantity obtainable is very small. In the application of natural manures of all kinds it is essential that the manure should be fine; that it be what is termed "short" manure.

COMMERCIAL FERTILIZERS.

It is desirable that only high-grade fertilizers be used in preparing the soil for growing crops in frames. Nitrogen is the essential element in the production of leaf growth, while potash and phosphoric acid are essential to fruit and seed production. The quantities of high-grade fertilizers that may be applied with safety and profit will vary according to the soil, but if a sufficient quantity of manure has been used it should not be necessary to add more than 1,000 to 1,500 pounds of commercial fertilizers to the acre each season.

A fertilizer for crops raised in frames should contain at least 7 per cent of nitrogen, 8 per cent of phosphoric acid, and 6 to 8 per cent of potash. Nitrate of soda can often be applied to advantage in order to hasten or increase the growth of the plants. It should be borne in mind, however, that nitrate of soda is a very concentrated and available form of nitrogen and that it is easy to overdo the matter and injure the plants; 300 pounds to the acre is considered the maximum quantity for a single application. Two or three such applications may be made during the growing season. Highly nitrogenous fertilizers should not be applied early in the winter, as these have a tendency to force the plants into a soft growth which will be easily injured by cold. For this reason nitrate of soda and similar fertilizers may best be applied as a top-dressing when it is desired to force the plants into a quick growth by scattering it between the rows and working it into the soil by means of a hoe or cultivator. Some growers have tried dissolving the nitrate of soda in water, 1 pound of the salt to 10 gallons of water, and watering the plants with this solution once every week or ten days during the height of the growing season.

WATERING CROPS IN FRAMES.

To insure success in the cultivation of plants in frames it is necessary to provide some means of applying water to the soil. Occasionally the supply of water can be obtained from the system of some city, but more often it must be pumped from a well or stream and stored for use in an elevated tank. The work of pumping the water is usually performed by a gasoline engine. The common round wooden storage tank, raised about 20 feet above ground, is in general use, and the water is delivered from the pump through a pipe, the end of which is carried up and over the top of the tank. A 4-horsepower engine is large enough to operate a pump having a capacity of about 40 gallons of water a minute. Such an equipment is sufficient for most establishments.

The irrigation systems in the Wilmington, N. C., district are often very elaborate. On some of the plantations a sprinkler system is employed, having large mains for conducting the water and a series of overhead pipes for distributing it through a great number of small nozzles. By this method the water can be applied during bright weather and while the cloth is drawn to one side for ventilation. The lines of distributing pipes are so arranged that the nozzles are all in a line, and the pipes can be rotated so as to throw the water in either direction, thus watering two or three beds from one line of pipe. (See fig. 1, p. 6.)

Where the sprinkler system of watering is not employed the work is generally done with 1-inch garden hose attached to pipes laid in the ground just deep enough to be out of the way of plowing and cultivation. At the points where it is necessary to attach the hose a tee is inserted in the pipe and the opening provided with a 1-inch globe or gate valve. These openings should be about 100 feet apart in one direction and in each alternate space between rows of frames in the other direction. The valves are protected by a square box of planks, about 8 by 10 inches in size and extending about 14 inches above ground. The valves should be about even with the surface of the soil; thus, the top portion of the box not only protects the valve from injury but also affords a support for the hose to prevent its bending sharply over the end of the pipe connection and thereby cutting off the flow of water. (Fig. 4.)

Many gardeners prefer to distribute the water by simply pinching the stream with the thumb, while others attach to the end of the hose a rose or sprinkler similar to that on a watering can. Watering is generally done during the late afternoon, but should be completed early enough to permit the foliage to become reasonably dry before closing the frames for the night. If the plants are young and very tender it will be important to avoid too great a degree of moisture.

Serious losses from "damping-off" often result from excessive moisture, especially at night, when evaporation is not so rapid as during the day. Many gardeners make the mistake of watering too often and not doing the work thoroughly. Under ordinary conditions twice a week will be often enough to apply water, and in winter, when evaporation is at its lowest point, once a week will be sufficient. In watering the sash-covered frames it is necessary either to remove the sash or to prop them up high enough to permit working under them. As a rule the sash are taken off early in the morning of a bright day, the soil is stirred, sometimes a little fertilizer is added, later in the day the bed is watered, and toward night the sash are replaced.

So far as is known, the subirrigation method has not been extensively or successfully applied to the watering of crops grown in frames. In order to make the subirrigation method successful it would be necessary to have conditions not ordinarily found in sandy loam soils.

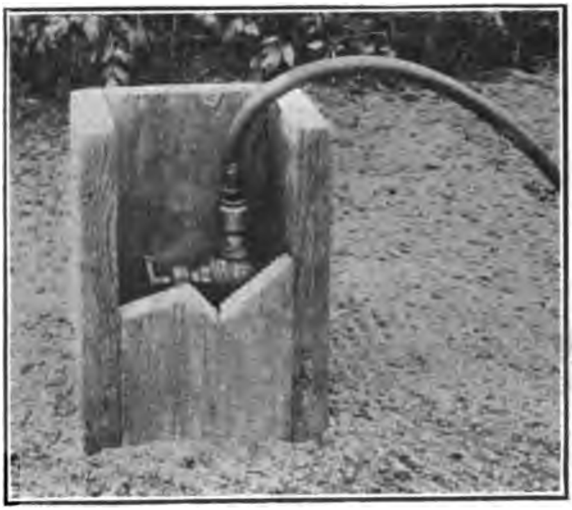

FIG. 4.—Box protector, showing valve and hose connection to water main.

TEMPERATURE, VENTILATION, AND PROTECTION OF FRAMES.

TEMPERATURE OF FRAMES.

The temperature at which the air of the beds should be carried will depend entirely upon the crop being grown Thermometers should be placed at intervals in the beds, as it is not safe to judge the temperature by personal sensation. If lettuce, parsley, or radishes are growing in the beds, the temperature should not go above 70° F. before ventilation is given; on the other hand, if the frames are filled with cucumbers, eggplant, or peppers, the temperature may run 8 or 10 degrees higher.

It should be borne in mind that any covering, whether cloth or sash, will exclude a part of the light, and every precaution is necessary to prevent the plants becoming "drawn." The safest plan is to keep the temperature a trifle low and thus retain the plants in a strong, thrifty condition. Where tender plants are being grown under cloth there is greater danger of injury from keeping them covered too tightly than from exposure to moderate cold.

VENTILATION OF FRAMES.

In the care of cloth-covered frames the covers are left off during bright weather and the plants subjected to open-air conditions. When there is danger of cold the covers are put on at night, and during unfavorable weather they are frequently left on during the day. While the cloth covers conserve the heat, they at the same time exclude the sunlight, and if they are kept on too great a portion of the time the crops will become drawn and spindling.

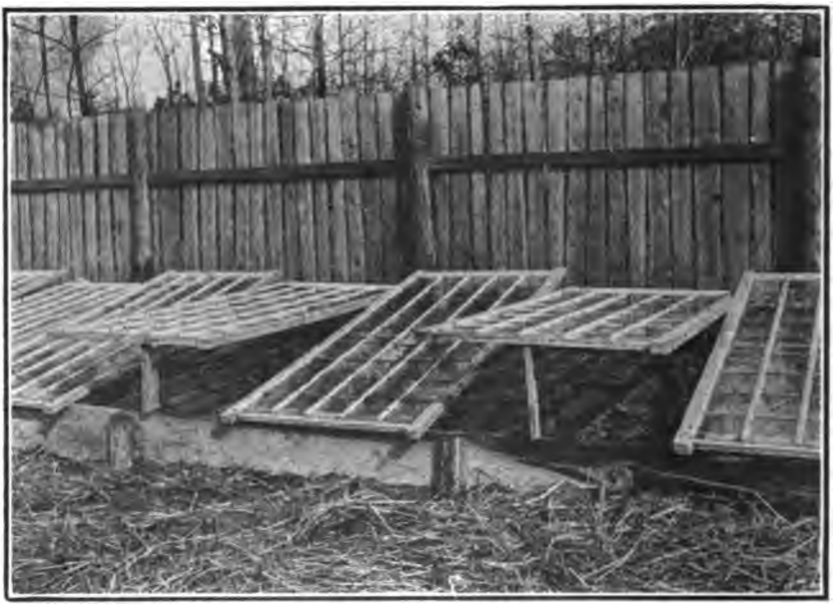

FIG. 5.—Sash-covered frames, showing a fence used to break the force of the wind and notched sticks used under the sash for ventilating the beds.

With sash-covered frames the matter of ventilation is of prime importance. The glass admits and holds the heat of the sun's rays, and during bright weather it is necessary to open the frames quite early in the morning. Ventilation is accomplished by propping up one end or one side of the sash on a notched stick, such as is illustrated in figure 5. Sometimes each alternate sash is lifted at opposite ends, or they may all be lifted at one end. If only a small amount of ventilation is required every other or every third sash is lifted a trifle; later, when more air is needed in the frames, the sash are raised higher and are finally removed altogether. The rule to be followed is to ventilate on the side away from the wind, so that the wind will blow over the opening and not into the bed.

PROTECTION OF FRAMES.

The area occupied by the frames is often surrounded by a high board fence or a hedge of evergreens to break the force of the wind. If a large area is devoted to frames it is sometimes subdivided by numerous cross fences to break up air currents and lessen the force of storms. The type of fence most commonly used is shown in figure 5.

Where no heat is applied to the frames the control over temperature will not be great except in the prevention of too high temperature by means of ventilation during bright weather. In many instances straw and burlap mats are kept ready at hand for throwing over sash-covered frames to prevent loss from freezing, but this would not be practicable on a large scale. Sometimes the glass is covered by shoveling one-half or three-fourths of an inch of soil over it, but this involves considerable labor and frequently results in the breakage of a great deal of glass. It is possible to ward off frost by the use of a number of orchard heaters in the frame yard. These heaters burn kerosene or crude oil and give off both heat and a smudge which will prevent injury from a reasonable degree of cold. A good type of orchard heater is shown in figure 6.

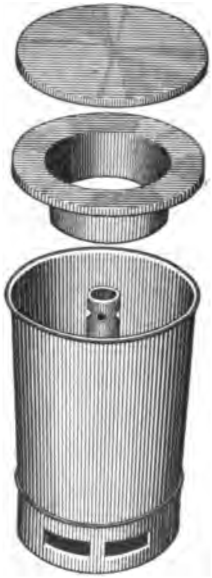

FIG. 6.—An oil heater holding 7 quarts of oil.

CROPS GROWN IN FRAMES.

The crops most commonly grown in frames are lettuce, radishes, cucumbers, garden beets, parsley, eggplant, peppers, and snap beans. The crops grown in the sash-covered frames do not differ materially from those grown under cloth. In the spring, however, the growers around Norfolk devote their beds almost entirely to cucumbers and eggplant instead of to lettuce and radishes. To the southward the cloth covers are sufficient to protect the more hardy crops throughout the winter. To the northward the hardy crops may be grown under sash in midwinter, and those requiring more heat are grown in the spring.

Descriptions of the methods used in handling the several crops grown in frames follow.

LETTUCE.

Lettuce may be considered as first in importance among the crops grown in frames. The more hardy types of head lettuce, such as Big Boston, are grown. A variety suited to frame work must be capable of withstanding considerable cold and exposure and at the same time produce a head that will find ready sale upon the market. Two crops of lettuce are usually grown, an autumn or early-winter crop and a late-winter or spring crop. The seed for the autumn crop is sown from August 15 to September 10, the plants being set in the beds from September 15 to October 15. As a rule, the plants are set about 8 by 10 inches apart in the beds. The autumn crop will be ready for market from November 20 to January 1. Seed for the spring crop is sown during October in the open ground or in beds and set in the frames as fast as the first crop is removed. The second crop will be ready for market from March 1 until superseded by the outdoor lettuce. (Fig. 7.) In order to secure stocky plants the seed bed should not be so rich as the soil where the crop is to be grown.

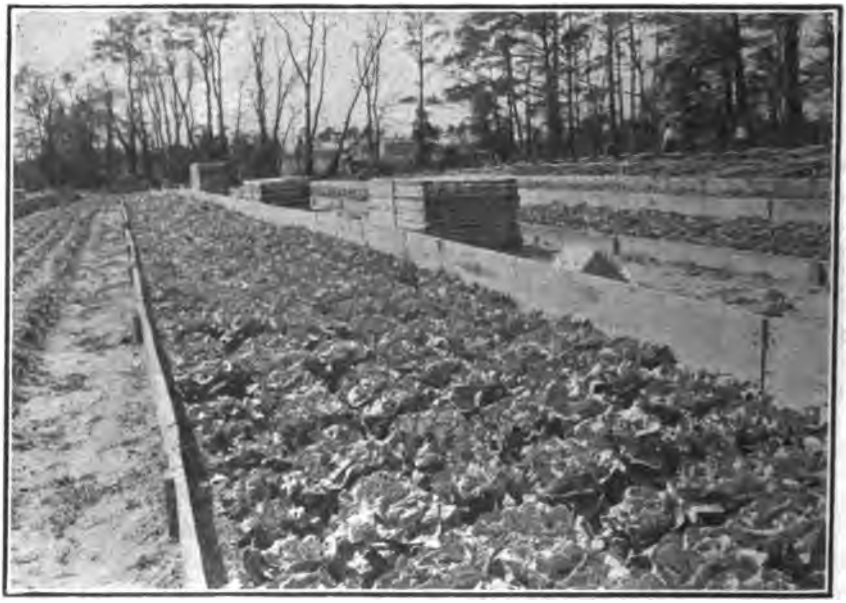

FIG. 7.—Lettuce growing in frames. The sash are piled between the beds ready for use in case of a cold snap.

As very little cultivation can be given the lettuce crop in the beds, it is essential that the soil should be well prepared and very rich. Plenty of organic matter is required, and this is best obtained by applications of well-rotted manure.

Lettuce does best under comparatively cool conditions, and plenty of ventilation is necessary. Heavy losses have resulted from the careless methods followed by many of the growers of lettuce in frames, especially as regards ventilation and watering.

RADISHES.

Radishes are frequently grown as a catch crop between the autumn and spring crops of lettuce, or as a filler between hills of cucumbers or between the plants of eggplant or peppers. The varieties most commonly used are Scarlet Globe, French Breakfast, Long Scarlet Short Top, and Icicle. The radish seed is simply sown in rows and the plants thinned so as not to crowd one another.

CUCUMBERS.

The cucumber is one of the most important of the crops grown in frames, especially around Norfolk. The cucumber crop is handled in the following manner: About the first of February, while most of the beds are occupied by lettuce and radishes, the cucumber plants are started in a hotbed in 1-quart berry boxes.

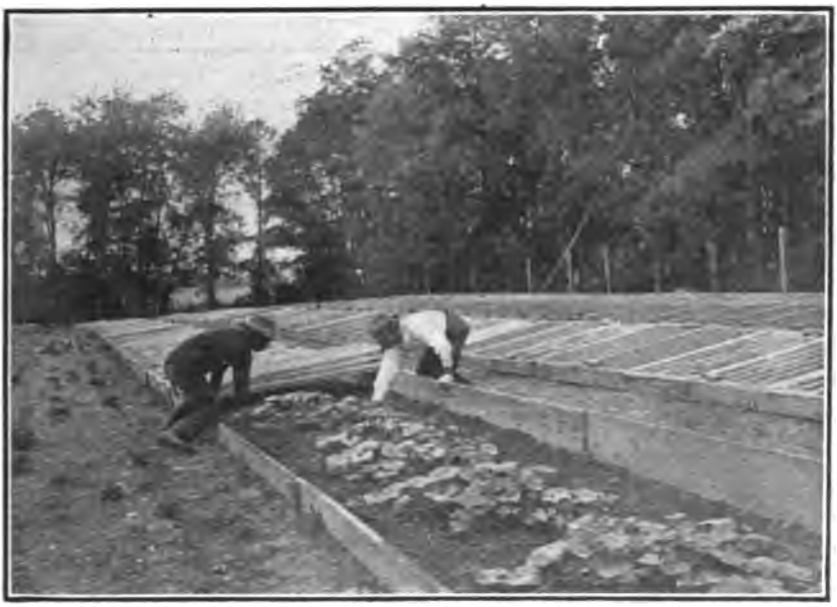

FIG. 8.—Cucumber vines growing in frames, about the time they begin to spread over the ground.

By some growers special 3-pint boxes, similar to the berry boxes, are used for this purpose. The boxes are filled with rich soil that has been thoroughly mixed and sifted, and 7 to 10 seeds are sown in each box. The boxes are then set directly in a manure hotbed and are kept watered until the seed germinates. When the plants appear they are thinned to about three in a box.

From the start great care is taken to give the plants sufficient ventilation to prevent their becoming spindling. If the plants should grow a little too tall it is customary to fill up the boxes with sifted soil to secure stocky, well-rooted plants for setting in the frames. By the time the cucumbers are ready for the frames and the lettuce and radishes have been marketed, the sash are removed from the 6-foot frames, and a deep double furrow is opened through the center of the bed by means of a one-horse plow.

While the plants are being grown in the hotbed the manure which is to be used in the frames has been composted. This is hauled and spread in the furrow, and the soil is returned to its former position by means of the plow. In planting, the boxes containing the hills of plants are lifted from the hotbed, placed in a wheelbarrow or in trays, and carried to the frames, where a small hole is dug, the main portion of the box removed by slitting with a knife, and the hill of cucumbers set in place and thoroughly watered. One hill is placed directly under the center of each sash.

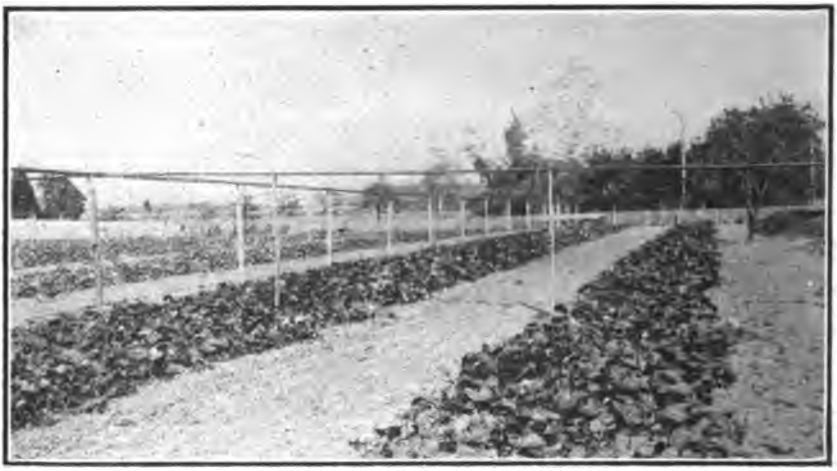

FIG. 9.—Cucumber vines after the removal of sash and frames.

In addition to the manure that is applied to the land before planting to cucumbers, frequent top dressings of chemical fertilizers are given. First, when the plants are just beginning to form vines a handful of fertilizer is scattered around each hill; none of this, however, is placed nearer than 6 or 8 inches from the hill. At the same time the soil is given a hoeing, and later in the day is watered. In about three weeks, when the vines are 18 inches or 2 feet long, the soil is given another dressing with fertilizer, this time making the application at a greater distance from the hills. The fertilizer generally used for this purpose contains about 7 per cent of nitrogen, 6 per cent of phosphoric acid, and 6 per cent of potash. The appearance of the cucumber vines at this stage is shown in figure 8.

About the time that the cucumber vines fill the entire space within the frame the weather will have become warm enough to leave the sash off, at first during the day and then during both the day and the night. A little later the sash are removed and piled at the ends of the frames, so that they may be quickly used to protect the beds in case of a late frost. After all danger of frost is past the sash are hauled and placed in the storehouse for the summer, and the boards forming the sides of the frames are removed and carefully piled in some convenient place where they will be protected. The cucumber vines are then turned up, first on one side and then on the other, a third top-dressing of commercial fertilizer is given, and the space between the rows formed by the removal of the frames is thoroughly cultivated. After cultivation the vines are again turned into place and allowed to occupy the entire space, as shown in figure 9. The beds are 6 feet in width and are generally placed 6 feet apart, forming a 12-foot space between the cucumber rows.

As a rule considerable fruit is gathered before the removal of the frames, but the largest pickings generally occur about two weeks later. If spraying is properly attended to, the cucumbers continue to produce until the field crop of the same locality is ready for shipment in large quantities. After the crop is no longer profitable the area should be cleared of all refuse and put in shape for the next year's operations. A crop of cowpeas may very conveniently be grown upon the land during the summer and used for hay or turned under.

PARSLEY.

Parsley is sometimes grown as an all-year crop, or it is grown during the autumn and winter and the land devoted to lettuce or cucumbers during the spring. The parsley seed is sown in August or September and the seedlings transplanted to the frames as soon as they are large enough to be handled. Cutting of the leaves begins in the autumn and continues throughout the winter, and often until quite late in the spring provided prices remain good. Parsley is not easily injured by cold, and it is customary to remove the sash and frames early in the spring and take them to some other location where they may be used for the growing of cucumbers, eggplant, or some other less hardy crop. Figure 10 shows parsley growing in frames from which the sash have been removed. Parsley is one of the easiest of crops to be grown in frames, and if a good market can be found it may prove very profitable.

EGGPLANT.

The seeds of the eggplants are started in heated beds or sometimes in small greenhouses. When the plants are large enough to handle they are transplanted from the seed bed to small pots, from which they are later shifted to 5-inch or 6-inch pots or to large berry boxes. Eggplants require plenty of heat and it is not safe to set them in the frames until the weather is quite warm, or about March 15 or 20 in the Norfolk region. As a rule the eggplants are set 18 or 20 inches apart each way in the beds among the lettuce. By the time the lettuce is removed the eggplants will be almost ready to begin fruiting. The sash are then removed and the eggplants given a top-dressing of fertilizer and cultivated.

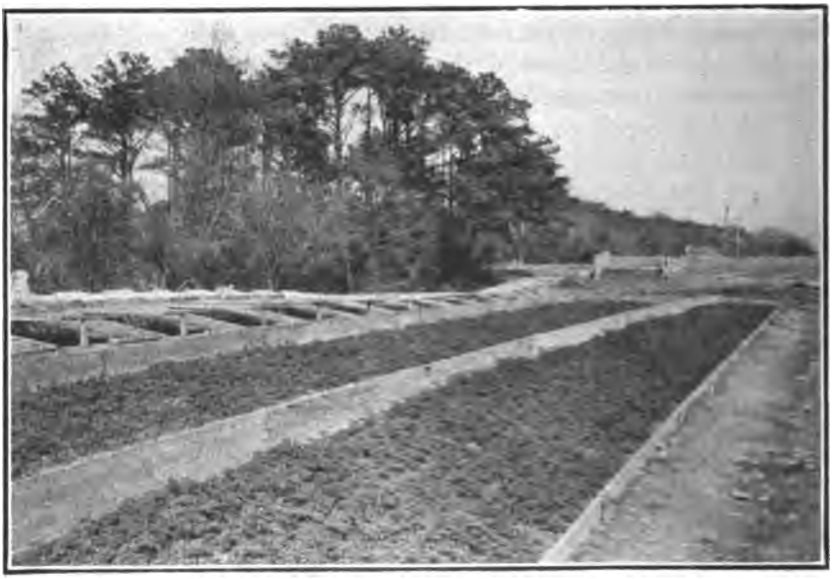

FIG. 10.—Parsley growing in frames.

PEPPERS.

The large, sweet peppers are sometimes grown in frames, the crop being handled in practically the same manner as eggplant. It is doubtful whether peppers grown in frames will ever give returns equal to those from eggplant and cucumbers.

GARDEN BEETS.

Two methods of growing beets in frames are practiced. By one method the plants are started in a special seed bed, and when of sufficient size they are transplanted to the cloth or sash covered frames, where they grow to a marketable size. By the other method the plants are simply started in the frames and then transplanted to the open ground to mature. Where the crop is grown under sash it is customary to remove the sash and frames after the beets have attained considerable growth (fig. 11), the frames and sash being used during the remainder of the season for cucumbers. The beets are marketed when about 2½ inches in diameter. The variety known as Early Egyptian is most commonly planted, although Crosby's Egyptian is sometimes used.

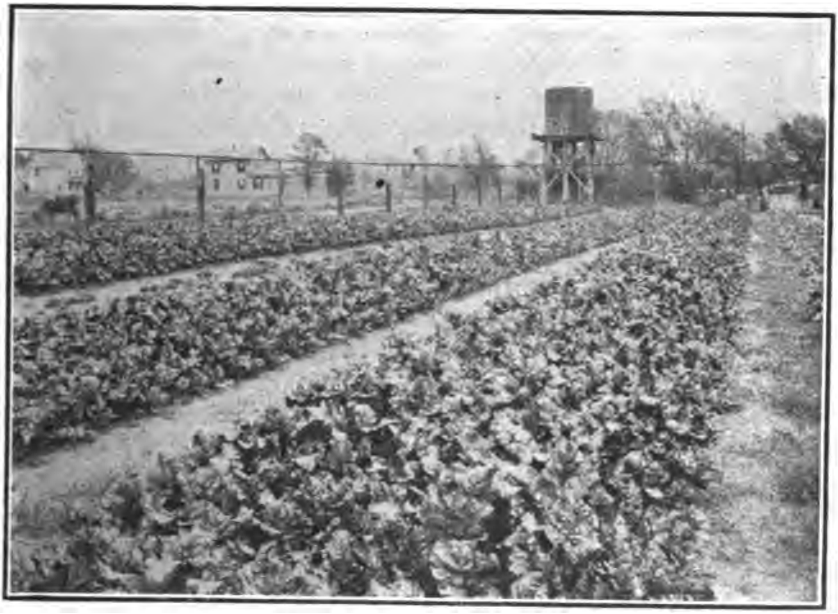

FIG. 11.—Beets growing in beds after the removal of frames.

SNAP BEANS.

A crop of snap beans is frequently grown by planting them in the beds beside every third row of spring-crop lettuce; then, after all danger of frost is past, the cloth is taken off and the entire frame removed, leaving the beans to grow as a field crop. The wax-podded varieties of beans are generally employed for this purpose.

At the North, after the spring lettuce crop has been removed, the frames are sometimes filled with early tomatoes (trained to stakes), early celery, or early plants for setting in the general garden.

PREVENTION AND CONTROL OF DISEASES AND INSECTS.

DISEASES.

The principal drawback to the growing of truck crops in frames, especially lettuce and cucumbers, is the danger of loss from diseases. Lettuce growers in the South Atlantic States have suffered heavy losses from the disease known as "drop." This is caused by a fungus (*Sclerotinia libertiana*) which attacks the plants as they approach maturity, causing them to wilt and afterwards decay. Preventive measures for this disease have been found by the North Carolina Agricultural Experiment Station to be based on three main principles: (1) That the fungus is incapable of infecting healthy plants unless it finds bits of dead leaves on which it can establish a foothold; (2) that it forms no spores, but reproduces itself through hard, black masses, which are formed only in the later stages of decay; and (3) that the spread of the disease in frames is favored by heavy watering and lack of ventilation. The lettuce grower should therefore exercise great care to keep all dead leaves picked from his plants and to remove and burn any plants which contract the disease at the first indications of wilt before the black masses are formed. Watering should be done only on bright days when it is possible to have the plants become fairly well dried off before the bed is closed for the night. When a piece of land becomes heavily infected with this disease the best policy is to move the frames to fresh soil, first disinfecting the woodwork with a 1 per cent solution of formaldehyde or a 0.5 per cent copper-sulphate solution.

If it is not possible to change the location of lettuce beds which are badly infected with "drop," and facilities are available, steam disinfection of the soil, which has proved an effective means of preventing the disease, may be used. The soil may be disinfected or sterilized by blowing live steam through drain tiles laid in the bottom of the beds or by means of an inverted pan under which steam is forced.

In the tile method of steaming, lines of 2-inch to 3-inch drain tiles are placed lengthwise in the beds, 2 to 2½ feet apart and 12 to 15 inches below the surface, and left there permanently. The tiles provide drainage for the beds, may be used for subirrigation, and are available at any time for disinfecting the soil, the only outlay of labor being the covering of the beds with boards, a tarpaulin, or a layer of straw, and the connecting of the tile with a boiler by means of a piece of steam hose. The soil need only be spaded or plowed deeply to loosen it.

The inverted-pan method of steaming involves the use of a galvanized-iron pan, 6 by 10 feet and 6 inches deep, which is inverted over the soil to be disinfected, the edges forced down into it, and steam admitted through a steam hose under pressure. The use of steam at a pressure of 80 to 100 pounds in the boiler and treatment for half an hour to an hour after the soil has reached the boiling point, as indicated by soil thermometers, has given the best results.

Cucumbers grown in frames are subject to downy mildew and anthracnose like those grown outside. These diseases may be effectively prevented by spraying with Bordeaux mixture. The formula usually recommended is 3 pounds of copper sulphate, 6 pounds of lime, and 50 gallons of water.[1] Nothing weaker than this should be used, while the 5-5-50 formula is preferred by some. It is essential that every part of the plant be thoroughly covered with a fine spray. Spraying should begin before the plants leave the hotbed and continue at intervals of ten days or two weeks. Toward the end of the season, if the diseases are prevalent in the neighborhood, the spraying should be done every four or five days.

INSECTS.

The injuries to frame crops due to the ravages of insects are of minor importance as compared to those of diseases; however, it is necessary to keep the insects under control or great damage may result. Aphids are quite troublesome, and cutworms occasionally play havoc, especially with young plants.

The aphids may generally be controlled by the liberal use of tobacco stems and dust sprinkled in the frames. Sometimes the beds are fumigated with tobacco stems or with aphis punk, which is burned in the tightly closed frames. Care must be exercised, however, to see that the application is not made too strong, or injury to the foliage may result.

Spraying with kerosene emulsion and soap preparations is effective in combating aphids, but such sprays are often objectionable for use on salad crops. The cucumber growers around Norfolk have found that if the tobacco stems are allowed to remain indefinitely on the beds they have an injurious effect upon the plants. Three or four days after the stems are applied they should be removed; then if the aphids are still present an application of fresh stems may be made.

Where cutworms are injuring lettuce and similar crops it is customary to put in baits of wheat bran or fresh clover leaves which have been poisoned by treatment with Paris green or arsenate of lead. For their protection when set out, the plants should be dipped or sprayed with a solution consisting of 1 pound of arsenate of lead to 25 gallons of water. Hand picking may prove effective whenever the insects are too numerous.[2]

MARKETING CROPS GROWN IN FRAMES.

Crops grown in frames are usually superior in quality and appearance to those grown in the open and should be given more care in handling and marketing. The cost of production is somewhat higher than for outdoor crops, and it is essential that they be put up in neat

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[1] See "Spraying for Cucumber and Melon Diseases," Farmers' Bulletin 231, U. S. Dept. of Agriculture.

[2] For further information on the control of aphids, the reader is referred to Circular 80, Bureau of Entomology, U. S. Dept. of Agriculture.

upon a rack or screen to drip before packing. Cucumbers are packed in two or three sizes of hampers with wooden covers; also in common, flat, half-bushel, handle baskets, covered with paper. A few growers employ a distinctive crate or box holding about a bushel. As a rule each box is lined with paper, and when filled the top is partly covered with slats, leaving the cucumbers slightly exposed.

Parsley is shipped in 1-bushel crates, half-barrel hampers, and in 4-bushel barrels. Sugar barrels are sometimes used. For some of the markets the parsley must be washed and tied in bunches, while for other markets it is shipped loose. When making shipments in the large barrels it is customary to place a block of ice in the top of each barrel, as shown in figure 12. The barrel is covered with a piece of burlap.

Radishes and beets are tied in bunches and shipped in hamper baskets or sometimes in the veneer barrels so commonly used for handling spinach and kale.

Eggplants are shipped in baskets or in crates like those used for handling strawberries. Each eggplant is usually wrapped separately in thin paper or inclosed in a paper bag.

Peppers are generally wrapped in tissue paper and packed in wooden pans, such as are used for marketing early tomatoes. Four or six of these wooden pans are packed in a carrier for shipment.

The snap beans that are grown in frames are shipped in the regular five-eighths bushel and half-barrel hamper baskets, such as are used for handling the general field crop.

SUMMARY.

In certain localities where the climate is mild, such crops as lettuce, radishes, and beets can be grown during the winter months if provision is made for protecting the plants during the few periods of freezing weather. The cheapest form of covering is cotton cloth or unbleached muslin.

In other localities, where the climate is too severe for growing crops under cloth protection, cheap sash filled with glass are effective. A good living can be made on 3 acres devoted to sash gardening.

Cheap hotbeds, constructed in long lines with plank sides, may be profitably employed for forcing vegetables for the market in the neighborhood of large cities, where an abundance of manure for heating material may be obtained.

The labor and expense involved in the growing of vegetables in frames are greater than for a corresponding area in the open; therefore greater care should be taken in gathering, packing, and marketing them in order that fancy prices may be obtained.

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Issued October 10, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 461.

THE USE OF CONCRETE ON THE FARM.

PREPARED BY THE OFFICE OF
PUBLIC ROADS.

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1911.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS,
Washington, D. C., May 17, 1911.

SIR: I have the honor to transmit herewith the manuscript of a bulletin prepared in this office on the subject of "The Use of Concrete on the Farm." In view of the need of securing a cheap and permanent building material, this bulletin seeks to offer elementary suggestions for the manufacture of concrete where it is most needed. I believe it will be useful to farmers, and therefore respectfully recommend that it be published as a Farmers' Bulletin, superseding Farmers' Bulletin 235.

Respectfully,
LOGAN WALLER PAGE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE USE OF CONCRETE ON THE FARM.

INTRODUCTION.

With the rapid decrease of our timber supply and the resulting increase in the price of lumber there has come a necessary demand for a new building material. Nowhere has this demand been felt more keenly than on the American farm, where lumber has till now been practically the only building material. On account, however, of the farmer's nearness to the timber itself, he has been the last to feel the full effect of the shortage.

A building material has been discovered in concrete that in many instances has proved to be far superior to lumber, brick, or building stones on account of its durability, economy, and safety from fire loss. Moreover, it can very often be used at the most convenient time by the farmer himself with a little assistance.

SELECTION OF MATERIALS.

Frequently cement users have made costly mistakes by not informing themselves properly, before starting their work, concerning the correct methods of making good concrete. For this purpose the following materials are necessary: (1) Cement; (2) sand; (3) gravel or crushed stone; and (4) water.

Cement is therefore only one part of a concrete mixture. A far greater proportion of sand and gravel than cement is required. The quantity of cement to be used and the strength of the concrete depend entirely on the quality and size of the sand and gravel, and it is of the utmost importance that these be of the right kind. With an equal amount of cement a far stronger concrete may be made, if the sand and gravel are of the proper size and correctly proportioned. It is sometimes thought that any kind of soil of a sandy nature, mixed with a small percentage of cement, will make concrete, but this idea is incorrect.

As a guide in the selection of the proper materials, especially sand and gravel, the following suggestions should be observed:

CEMENT.

Portland cement is a manufactured product, the principal value of which is its ability to adhere to the various materials used in masonry construction. Most of the American brands of Portland cement are made under the careful supervision of the manufacturer, who has his reputation at stake. They have to meet the requirements of a fixed standard which has been, after years of experimenting, adopted by the American Society for Testing Materials and the American Society of Civil Engineers. Guarantees should be obtained from the dealer or manufacturer that the Portland cement furnished meets this standard.

On adding water to the dry cement it becomes a soft, sticky paste, and will remain so for about one-half hour, after which it begins to harden or "set." To disturb the concrete after this initial set has started means a decided loss in strength, while to disturb it after the set is well under way means to destroy the concrete. It should, therefore, be remembered that Portland cement concrete must be placed in position within 20 or 30 minutes from the time it is first wet.

There are also several other minor considerations to be observed. First, the binding power of Portland cement is lessened by exposing the concrete to a hot sun during the first four or five days after it has been placed in position. Then, a green cement mixture, which can be easily frozen at a temperature below 32° F., should be protected from such an exposure. Freezing does not materially affect the binding quality of good Portland cement, provided the concrete does not freeze until after placing and is not subjected to any load until after it has been thawed out and allowed to "set" in the usual way. It is safest to avoid mixing on days when the temperature is below the freezing point, that is, 32° F. In no case should fresh manure be placed over very green concrete to protect it from freezing, because this will soil the surface of the concrete.

Portland cement is shipped in paper bags, cloth sacks, or wooden barrels. The second means is, for the average user, the best, and, while the manufacturers charge more for this kind of a package, they allow a rebate for the return of the empty bags.

Cement is manufactured in 25 States in the United States and can be obtained easily in all sections of the country. Of the various kinds of cements made, Portland cement is without question the best.

Cement must be kept in a dry place. It absorbs moisture from the atmosphere with great readiness and, when kept in a damp place, soon becomes lumpy or even a solid mass. In this condition it is useless and should be thrown away. But lumps caused by pressure in the storehouse must not be mistaken for cement that has been wet and has then formed into lumps. Lumps caused by pressure are easily broken and the cement is perfectly good.

In storing cement wooden blocks should be placed on the floor and covered with boards. The cement should then be piled on the boards and the pile covered with canvas or a piece of roofing paper.

SAND.

In the selection of sand the greatest care should be used, and critical attention should be given to its quality, for sand contributes from one-third to one-half of the amount of the materials used in making concrete.

Sand may be considered as including all grains and small pebbles that will pass through a wire screen with ¼-inch meshes, while gravel in general is the pebbles and stones retained upon such a screen.

The sand should be clean, coarse, and if possible free from loam, clay, and vegetable matter. It was proved in an actual test made by a United States Government expert that an exceedingly fine sand required seven times the amount of cement required by coarser sand retained on a 20-mesh screen, without increasing the strength of the concrete.

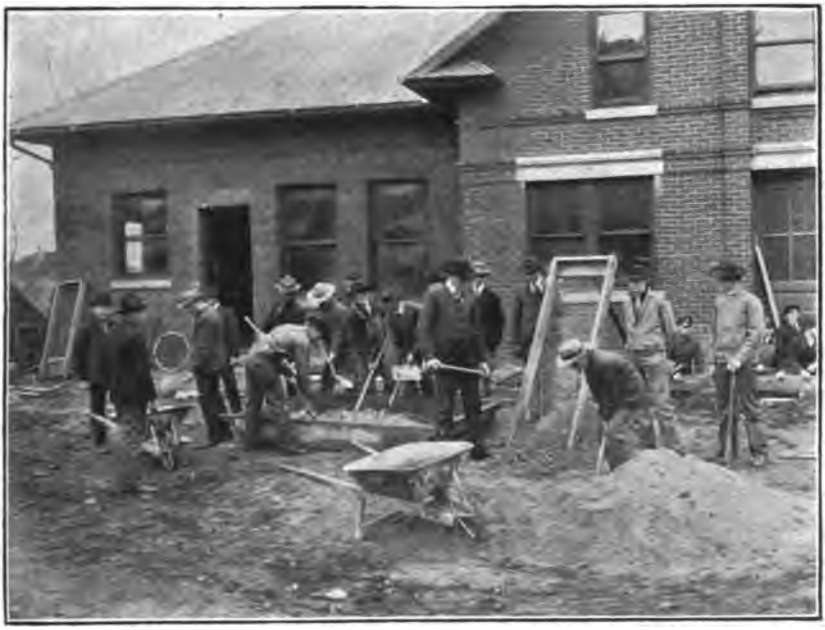

FIG. 1.—Method of screening sand from gravel.

Sand from the same bank usually varies largely in different places in the bank and, as sand of such fineness that over 50 per cent of the bulk of the sand will pass through a 40-mesh screen is generally unfit for concrete work, it may become necessary to screen out this very fine sand by means of a 40-mesh wire screen. A 40-mesh screen means a screen with 40 holes to the lineal inch of screen surface. The screen should be placed in an upright position at an angle of about 45 degrees. The screening should be done at the pit, in order that only the material actually used may be hauled.

Sand with the grains of nearly uniform size does not give as great strength as sand with grains of various sizes. By testing concrete made from coarse and fine sand of one size of grains, it will be found that the coarse sand gives the stronger concrete. The strength and hardness of the grains of sand are of much importance; and a sand which shows the slightest tendency to dissolve or soften when soaked in water for an hour should be discarded.

The coarseness of the sand can be felt, or can be determined by a screen, and the vegetable matter can be seen, but the amount of clay or loam can not be decided in either of these ways. Four inches of sand should be put in a pint preserving jar and, when the jar has been filled with clear water to within an inch of the top, the lid should be fastened on and the jar shaken vigorously for 10 minutes. The jar should then be rested upright and the contents allowed to settle. The sand will settle in the bottom with the clay and the loam on top, and the water above them. If more than one-half inch of clay or loam shows, the sand should be rejected or washed. The difference in color and fineness shows clearly the line of division between the clay or loam and the sand.

If the sand must be washed, the simplest way is to build a loose board platform from 10 to 15 feet long, with one end 12 inches higher than the other. On the lower end and on the sides an edge 2 inches by 6 inches should be nailed to hold the sand. The sand should be spread over the platform in a layer 3 or 4 inches thick and washed with a ¾-inch garden hose. The washing should be started at the high end and the water allowed to run through the sand and over the 2-inch by 6-inch piece at the bottom. A small quantity of clay or loam does not injure the sand, but any amount over 10 per cent should be washed out.

GRAVEL.

The largest part of concrete is the gravel or crushed stone. This should be clean; that is, free from loam, clay, or vegetable matter. The best results are obtained from a mixture of sizes graded from the smallest, which is retained on a ¼-inch screen, to the larger ones that will pass a 1½-inch ring.

For heavy foundation and abutment work, larger sized pebbles and stones might be used, while for reinforced concrete work pebbles larger than those passing a 1-inch ring should not be used.

If crushed stone and screenings are used, the same care in selecting the sizes must be exercised as in selecting the gravel. In ordering from the crusher plant, the sizes of the stone and screenings should be specified in the order. The crusher dust should always be removed.

Sometimes bank or creek gravel, which will answer the purpose of sand and gravel combined, can be obtained, and it is frequently used on the farm and in small jobs of concrete work just as it comes from the pit or creek. Occasionally this gravel contains nearly the right proportions of sand and gravel, but in the majority of sand pits and gravel banks there is a great variation in the sizes of the grains and pebbles or gravel, and in the quantities of each. This is due to the fact that all the deposits are formed in seams or pockets that make it impossible to secure anything like uniformity. Therefore, to get the best and cheapest concrete, it is advisable to screen the sand and gravel and to remix them in the correct proportions.

Experienced contractors have found that it is not only necessary but economical to pay laborers as much as $2 per day to screen the bank material twice, in order to obtain the sand and gravel. First, a one-fourth-inch screen should be used to keep out the gravel, and then the material which has passed through this screen should be screened again over a 40-mesh screen for the sand. All material which passes through this 40-mesh screen should be rejected.

By knowing exactly the proportions of sand and gravel, the exact amount of cement to obtain the desired strength can be determined. Enough cement can be saved to balance the additional pay given to the laborers for screening the sand and gravel.

Dirty gravel can usually be observed without further test, and can be washed in the same way as dirty sand.

WATER.

The water used for concrete should be clean and free from strong acids and alkalis.

MANUFACTURE OF CONCRETE.

PROPORTIONS.

Concrete is a manufactured stone formed by mixing cement, sand, and stone or gravel (i. e., pebbles) together with water. Various amounts of each are used, according to the use to which the concrete is to be put. The mixture in which all the spaces or voids between the stones or gravel are filled with sand and all the spaces between the sand are filled with cement is the ideal mixture. This mixture is rarely obtained, since the voids in each load of gravel and sand vary slightly, and in order to be absolutely safe, a little more sand and cement than will just fill the voids are used. The following illustration (Fig. 2) shows the relative amounts of these various materials for a certain amount of 1 : 2 : 4 concrete. It will be noticed that the amount of concrete is only slightly greater than the amount of stone or gravel.

TABLE I.—*Quantities of materials and the resulting amount of concrete for a two-bag batch.*

Kinds of concrete mixture.	Proportions by parts.			Materials.			Concrete (cubic feet).	Sizes of measuring boxes (inside measurements).		Water for medium wet mixture (gallons).
	Cement.	Sand.	Stone or gravel.	Cement (bags).	Sand (cubic feet).	Stone or gravel (cubic feet).		Sand.	Stone or gravel.	
1:2:4	1	2	4	2	3¾	7½	8½	2 feet by 2 feet by 11½ inches.	2 feet by 4 feet by 11½ inches.	10
1:2½:5	1	2½	5	2	4¾	9½	10	2 feet by 2 feet 6 inches by 11½ inches.	2 feet 6 inches by 4 feet by 11½ inches.	12½

Table I shows the amount of stone, sand, and cement used in the various grades of concrete work. The proportions are always measured by volume. A 1:2:4 mixture means one part of cement, twice as much sand, and four times as much stone or gravel, so that the whole mixture consists of seven parts. A 1:2½:5 mixture means one part of cement, two and one-half times as much sand, and five times as much stone or gravel, so that the whole mixture consists of eight and one-half parts.

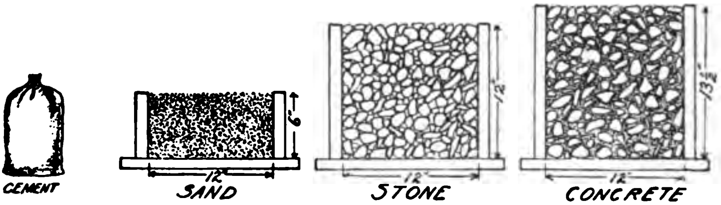

FIG. 2.—Required quantities of cement, sand, and stone or gravel for a 1:2:4 concrete mixture and the resulting quantity of concrete.

MEASURING BOXES.

It should be noticed that the dimensions given for the measuring boxes for sand and stone or gravel are inside measurements. These boxes are made with straight sides of any kind of rough boards and have no top or bottom.

AMOUNT OF WATER.

The amount of water given is only approximated. The amount given in Table I should be used for the first batch; if it is too wet for the use desired, the amount should be reduced, while if it is too dry, the amount should be increased. A bucket should always be used in measuring the amount of water, as this secures uniform results.

VARIATIONS IN MIXTURE.

If the sand is very fine, the cement should be increased from 10 to 15 per cent.

When the mixture does not have a uniform color, but looks streaky, it has not been fully mixed.

If the mixture does not work well, and the sand and cement do not fill the voids in the stone, the percentage of stone should be reduced slightly, but the concrete should first be properly mixed. Concrete that is poorly mixed may present features that are entirely eliminated by turning it over once or twice more.

METHOD OF MEASURING QUANTITIES.

One barrel of Portland cement holds practically 4 cubic feet, or 4 bags of cement. Sand and stone or gravel are measured loose in the boxes and should not be packed. A 2-bag batch of concrete requires 2 bags of cement, while the amount of sand and stone or gravel is measured as shown in Table I. For a 4-bag batch twice as much sand and stone or gravel and 4 bags of cement should be used.

DETERMINATION OF QUANTITIES.

The number of cubic feet of concrete that will be required for the work in question should first be calculated. By multiplying this number by the number under the proper column, as shown in Table II below, the amount of cement, sand, and stone or gravel can be found.

TABLE II.—*Quantities of materials in 1 cubic foot of concrete.*

Mixture of concrete.	Cement (by barrels).	Sand (by cubic yards).	Stone or gravel (by cubic yards).
1:2:4	0.058	0.0163	0.0326
1:2½:5	.048	.0176	.0352

Example.—Let us suppose that the work consists of a concrete silo requiring in all 935 cubic feet of concrete, of which 750 cubic feet are to be 1:2:4 concrete, and 185 cubic feet are to be 1:2½:5 concrete. Enough sand and cement are also needed to paint the silo inside and outside, amounting in all to 400 square yards of surface, with a 1:1 mixture of sand and cement. One cubic foot of 1:1 mortar paints about 15 square yards of surface and requires 0.1856 barrel of cement and 0.0263 cubic yard of sand. The problem thus works out as follows:

Cement:	Barrels.
For the 750 cubic feet of 1:2:4 concrete (750×0.058)	43.5
For the 185 cubic feet of 1:2½:5 concrete (185×0.048)	8.9
For painting (400÷15×0.1856)	4.9
Total amount of cement	57.3

Sand:	Cubic yards.
For 750 cubic feet of 1 : 2 : 4 concrete (750×0.0163)	12.23
For 185 cubic feet of 1 : 2½ : 5 concrete (185×0.0176)	3.26
For painting (400÷15×0.0263)	.70
Total amount of sand	16.19
Stone or gravel:	
For 750 cubic feet of 1 : 2 : 4 concrete (750×0.0326)	24.5
For 185 cubic feet of 1 : 2½ : 5 concrete (185×0.0352)	6.5
Total amount of stone or gravel	31.0

Thus the necessary quantities of materials are about 57½ barrels of Portland cement, about 16¼ cubic yards of sand, and 31 cubic yards of stone or gravel. It is always wise to order two or three extra barrels of cement if the dealer is at considerable distance, as this avoids any possible trouble that a shortage might cause.

In case a natural mixture of bank sand and gravel is used, the following table should be consulted for the quantities of the mixture:

TABLE III.—*Quantities of materials and the resulting amount of concrete for a 2-bag batch, using a natural mixture of bank sand and gravel.*

Kind of concrete mixture.	Proportions by parts.		Materials.		Concrete (cubic feet).	Sizes of measuring boxes, mixture of sand and gravel.	Water for medium wet mixture (gallons).
	Cement.	Natural mixture of sand and gravel.	Cement (bags).	Natural mixture of sand and gravel (cubic feet).			
1:4	1	4	2	7½	8½	2 feet×4 feet×11½ inches	10
1:5	1	6	2	9½	10	2 feet 6 inches×4 feet×11½ inches	12½

EQUIPMENT FOR MIXING CONCRETE.

When the proper materials have been selected, the next step is to mix them properly and with dispatch. On large jobs it is more economical to mix concrete by machine, but for small jobs, using even as much as several hundred cubic yards of concrete, it is much cheaper and more expedient to mix by hand. This is, of course, especially true when only two or three men are available and the work is often interrupted. There are many ways of mixing by hand, all of which have the same good results. The way herein described is believed to be the one best calculated to obtain good results with a minimum of labor. In this description and the accompanying illustrations, a 2-bag batch of 1:2:4 concrete is taken as the basis of the calculation.

The Concrete Board.—A concrete board for two men should be 9 feet by 10 feet. It should be made of 1-inch boards, 10 feet long, surfaced on one side, and should be held together by five 2-inch by 4-inch by 9-foot cleats. If tongue and groove roofers 1 inch by 6 inches can be obtained, fairly free from knots, they serve very well. The boards are surfaced in order to make the shoveling easy. They are so laid as to permit the shoveling to be done in the direction in which the cracks run, so that the shovel points will not catch in the cracks. The boards must be nailed close together so that no cement grout may run through them during the mixing. Knot holes may be closed by nailing a strip across them on the underside of the board. It is a good precaution against losing cement grout to nail a piece of wood 2 by 2 inches or 2 by 4 inches around the outer edge of the board. Often 2-inch planks are used in making concrete boards, but these are unnecessarily heavy and very difficult to move.

The concrete board is the manufacturing plant, and the advantages of its location should be carefully considered. Generally it is best placed as close as possible to the forms in which the concrete is to be deposited, but local conditions must govern this point. A place should be selected which affords plenty of room and is near the storage piles of sand and stone or pebbles. The concrete board should be raised on blocks so as to be level, in order that the cement grout may not run off on one side and that the board may not sag in the middle under the weight of the concrete.

Runs.—The boards for the wheelbarrow runs should be carefully selected. The run should be well built, smooth, and at least 20 inches wide, if much above the ground. It is surprising how this one feature will lighten and quicken the work.

Miscellaneous Tools.—The following is a list of the tools and plant to be used in mixing, giving sizes, quantities, etc.

The lumber for the concrete board for a 2-bag batch, 9 feet by 10 feet in size, is as follows:

9 pieces ⅞ inch by 12 inches by 10 feet, surfaced on one side and two edges.[1]
5 pieces 2 inches by 4 inches by 9 feet, rough.
2 pieces 2 inches by 2 inches by 10 feet, rough.
2 pieces 2 inches by 2 inches by 9 feet, rough.

The lumber for the concrete board for a 4-bag batch, 12 feet by 10 feet in size, is as follows:

12 pieces ⅞ inch by 12 inches by 10 feet, surfaced on one side and edges.[1]
5 pieces 2 inches by 4 inches by 12 feet, rough.
2 pieces 2 inches by 2 inches by 10 feet, rough.
2 pieces 2 inches by 2 inches by 12 feet, rough.

For the runs, planks 2, 2½, or 3 inches thick and 10 or 12 inches wide are needed.

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[1] Here any width of plank may be used, but 12 inches is specified as the most convenient.

The measuring boxes for the sand and stone or gravel should have the following dimensions:

For a 2-bag batch with the 1 : 2 : 4 mixture:

4 pieces 1 inch by 11½ inches by 2 feet, rough (for the ends of the sand and stone boxes).
2 pieces 1 inch by 11½ inches by 4 feet, rough (for the sides of the sand box).
2 pieces 1 inch by 11½ inches by 6 feet, rough (for the sides of the stone box).

[It should be noted that the 2 pieces 4 feet long and the 2 pieces 6 feet long have an extra foot in length at each end for the purpose of serving as a handle.]

For a 2-bag batch with the 1 : 2½ : 5 mixture:

2 pieces 1 inch by 11½ inches by 2 feet (for the ends of the sand box).
2 pieces 1 inch by 11½ inches by 2½ feet (for the ends of the stone box).
2 pieces 1 inch by 11½ inches by 4½ feet (for the sides of the sand box).
2 pieces 1 inch by 11½ inches by 6 feet (for the sides of the stone box).

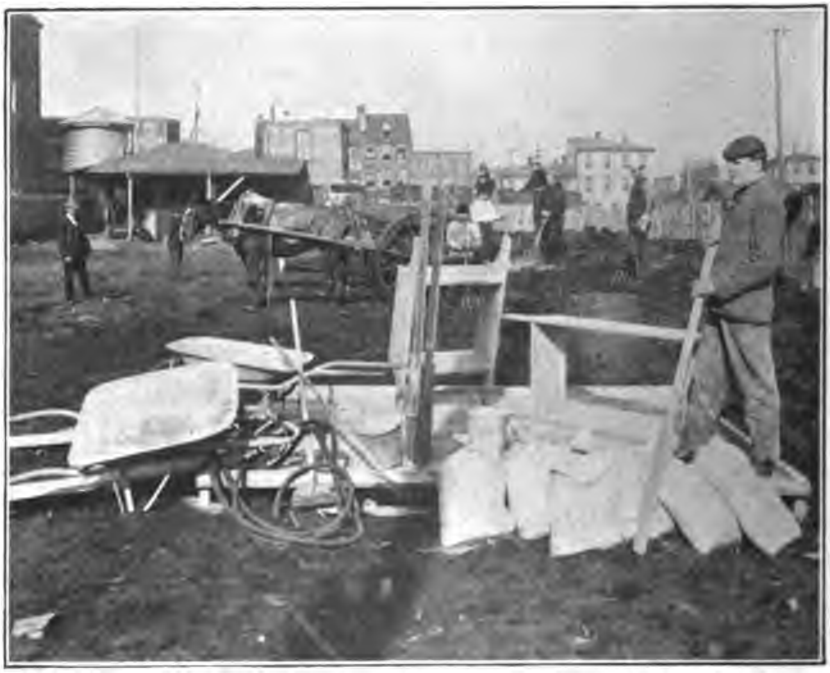

FIG. 3.—Concrete board and various tools used in making concrete.

[As in the preceding case, the 2 pieces 4½ feet long and the 2 pieces 6 feet long have an extra foot in length at each end to serve as handles.]

For a 4-bag batch (these figures can be obtained by doubling the cubic contents of the boxes as shown above).
Shovels: No. 3, square point.
Wheelbarrows: At least two are necessary for quick work, and those with a sheet-iron body are to be preferred.
Garden rake.
Water barrel.
Water buckets, 2-gallon size.
Tamper: 4 inches by 4 inches by 2 feet 6 inches, with handles nailed to it.
Garden spade or spading tool.
Sand screen, which can be made by nailing a piece of ¼-inch-mesh wire screen, 2½ by 5 feet in size, to a frame made of boards 2 by 4 inches.

METHOD OF MIXING.

When the mixing board has been arranged and the "runs" are made, the concrete plant is ready. The sand should first be loaded in wheelbarrows and wheeled on the board. It should then be emptied into the sand-measuring box, which is placed about 2 feet from one of the 10-foot sides of the board, as shown in figure 4. When the sand box is filled it should be lifted off and the sand should be spread over the board in a layer 3 or 4 inches thick. Two bags of cement should then be spread as evenly as possible over the sand. Two men, stationed as shown in figure 6, should then start mixing the sand and cement in such a way that each man may turn over the half on his side of a line dividing the board in half. Starting at his feet and shoveling away from himself, each man should take a full shovel load, and in turning the shovel, he should not simply dump off the sand and cement, but should shake the materials off the end and sides of the shovel, so that they may be mixed as they fall. This is a means of great assistance in mixing these materials, and in this way the material is shoveled from one side of the board to the other.

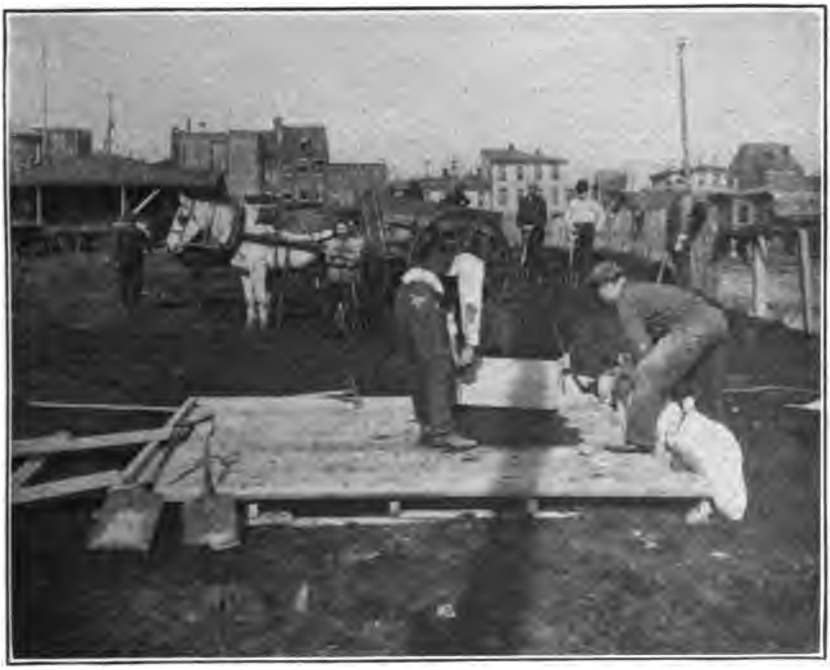

FIG. 4.—Measuring the sand.

The sand and cement should now be well mixed and ready for the stone and water. After the last turning, the sand and cement should be spread out carefully, and the gravel or stone measuring box should then be placed beside them and filled from the gravel pile. The box should now be lifted off, the gravel shoveled on top of the sand and cement, and spread as evenly as possible. With some experience, equally good results may be obtained by placing the gravel-measuring box on top of the carefully leveled sand and cement mixture, and filling it, so that the gravel is placed on top without an extra shoveling. About three-fourths of the required amount of water should be added with a bucket, and the water should be dashed over the gravel on top of the pile as evenly as possible. Care should be taken not to let too much water get near the edges of the pile, because it may wash away some of the cement as it flows off. This caution, however, does not apply to a properly constructed mixing board, where water can not flow away. Starting in the same way as with the sand and cement, the materials should be turned over in much the same manner, except that, instead of shaking them off the end of the shovel, the whole shovel load should be dumped and dragged back toward the mixer with the square point of the shovel. The wet gravel picks up the sand and cement, as it rolls over when dragged back by the shovel, and the materials are thus thoroughly mixed. Water should be added to the dry spots as the mixing goes on until all that is required

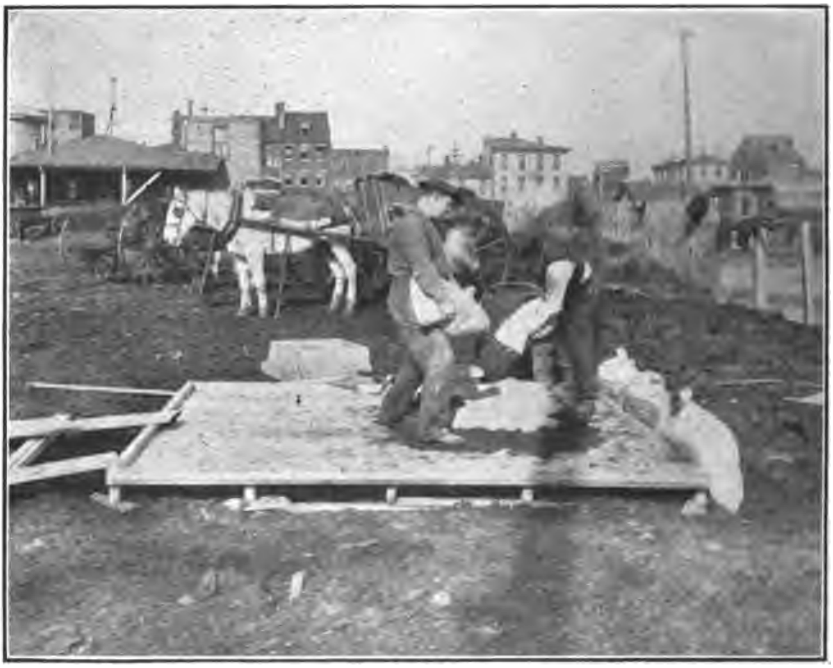

FIG. 5.—Spreading the cement on top of the sand.

has been used. The mass should be turned back again, as was done with the sand and cement. With experienced laborers, the concrete would be well mixed after three such turnings; but if it shows streaky or dry spots, it must be turned again. After the final turning, it should be shoveled into a compact pile. The concrete is now ready for placing.

When a natural mixture of sand and gravel is to be used, the materials should be measured by means of the right measuring box for the proper proportion, as shown in Table No. 3. The mixture of sand and gravel should be spread out and enough water added to wet it thoroughly. The cement should be distributed evenly in a thin layer over the sand and gravel and turned over, as described previously, at least three times, while the rest of the water necessary to get the required consistency should be added as the materials are being turned. It requires good judgment to prepare a natural mixture of bank sand and gravel, and, if one is at all doubtful about the concrete made from it, the sand should first be screened from the gravel as described above and then mixed in the regular way.

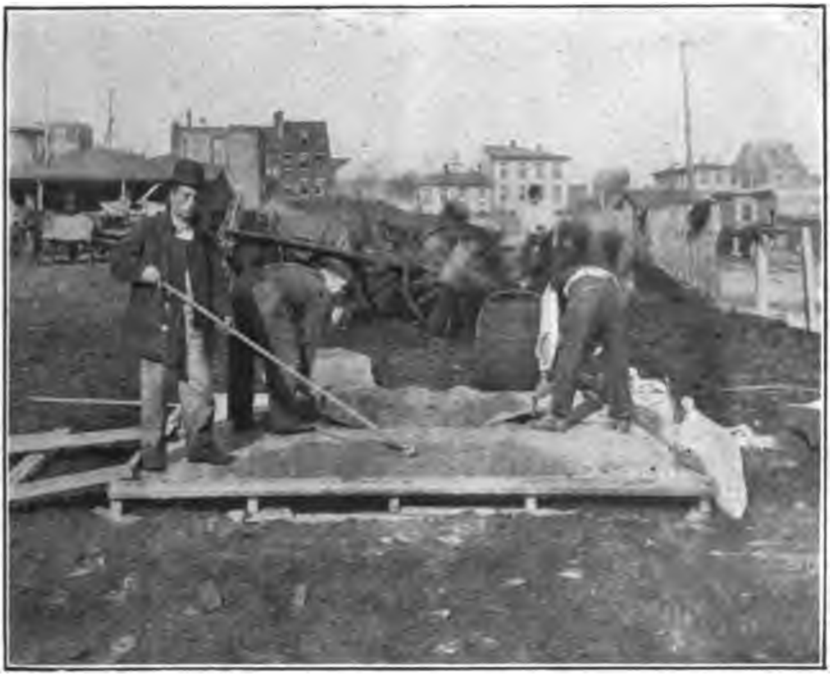

FIG. 6.—Mixing the sand and cement.

For the operation of mixing only two men are required, although more can be used to advantage. If three men are available, two of them should mix as described above and the third man should supply the water and help in mixing the concrete by raking over the dry or unmixed spots, as the two mixers turn the concrete, and in loading the wheelbarrows with sand and stone or gravel.

If four men are available, it is best to increase the size of the batch mixed to a 4-bag batch by doubling the quantities of all materials used. The cement board should also be increased to 10 feet by 12 feet, as shown on page 13. In this case the mixing should be started in the middle of the board, and each pair of men should mix exactly as for a 2-bag batch, except that the concrete is shoveled into one big mass each time that it is turned back on the center of the board.

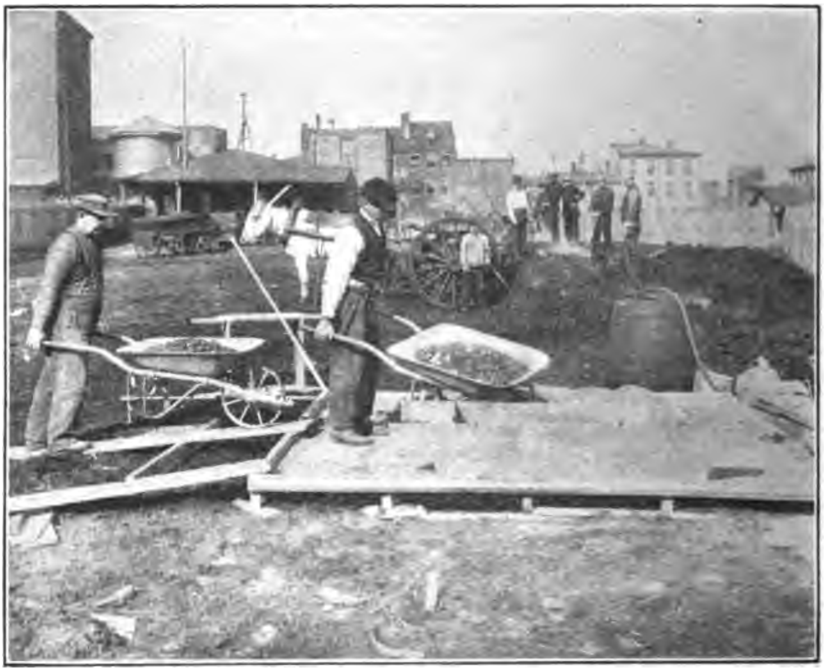

FIG. 7.—Emptying the gravel in the measuring box to the side of the sand and cement.

PLACING THE CONCRETE.

Method.—After the concrete is properly mixed, it should be placed at once. Concrete may be handled and placed in any way best suited to the nature of the work, provided that the materials do not separate in placing. Concrete may be placed properly by shoveling off the concrete board directly into the work; by shoveling into wheelbarrows, wheeling to the proper place, and dumping; by shoveling down an inclined chute; or by shoveling into buckets and hoisting into place. Concrete should be deposited in layers about 6 inches thick, unless otherwise specified.

Consistency.—The following three kinds of mixtures are used in general concrete work:

(1) Very wet mixture: Concrete wet enough to be mushy and run off a shovel when being handled is used for reinforced work, thin walls, or other thin sections, etc.; with it no ramming is necessary.

(2) Medium mixture: Concrete just wet enough to make it jelly-like is used for some reinforced work and also for foundations, floors, etc. It requires ramming with a tamper to remove air bubbles and to fill voids. This concrete is of a medium consistency and would sink in under the weight of a man.

(3) Dry mixture: In this case the concrete is like damp earth. It is used for foundations, etc., where it is important to have the concrete put in position as quickly as possible. This must be spread out in a layer from 4 to 6 inches thick and thoroughly tamped until the water flushes to the surface.

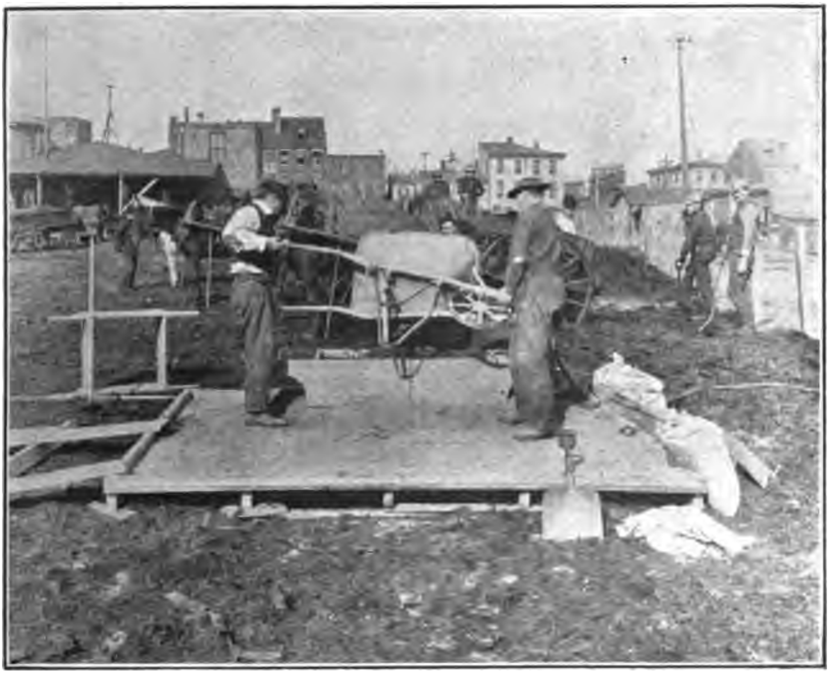

FIG. 8.—Measuring the gravel by dumping it on top of the sand and cement mixture.

The difference between the mixtures is that the drier mixture causes the concrete to "set up" more quickly. In the end, however, when carefully mixed and placed, the results from any of the above mixtures will be the same. A dry mixture, to be sure, can not be used readily with reinforcing steel, and is both more expensive and harder to handle. It must be protected with greater care from the sun or from drying too quickly, and unless spaded by very experienced hands it may show voids or stone or gravel pockets in the face of the work when the forms are removed.

Spading.—Concrete of any of the three degrees of consistency mentioned above should be carefully spaded next to the form where the finished concrete will be exposed to view. Spading consists of running a spade or flattened shovel down against the face of the form and working up and down. This action causes the stone or gravel to be pushed back slightly from the form and allows the cement grout to flow against the face of the form and fill any voids that may be there, so that the face of the work will present an even, homogeneous appearance. Where the narrowness of the concrete section, such as in a 6-inch side wall, prevents the use of a spade, a board 1 inch by 4 inches, sharpened to a chisel edge on the end, serves as well. This board should be sharpened only on one side and the flat side should be placed against the form. In the case of a dry mixture spading must be done with the greatest care by experienced hands to get uniform results, but with a medium or wet mixture it is very easy to obtain first-class work; indeed, with a wet mixture spading is required only as an added precaution against the possibility of voids in the face of the work and is really necessary in few cases.

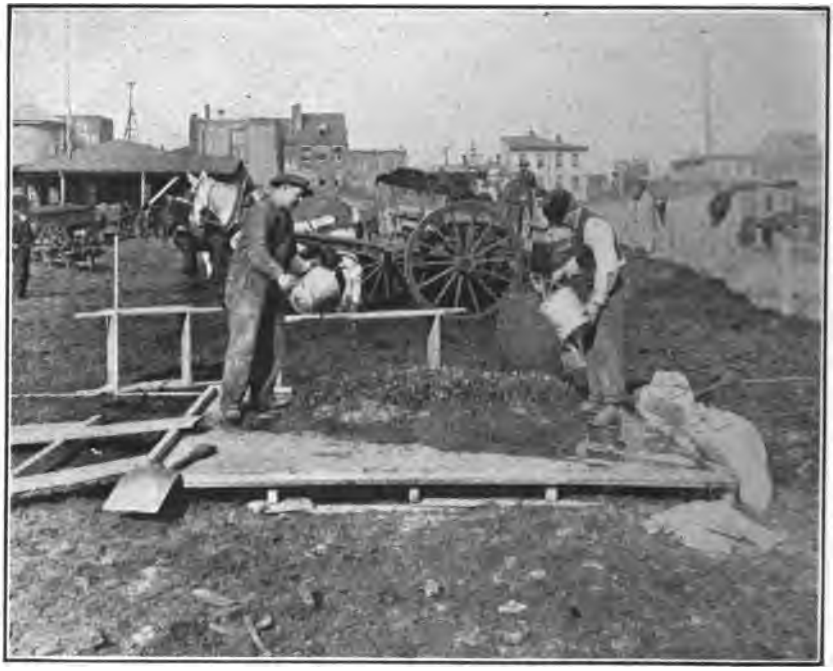

FIG. 9.—Pouring water over the mixture of sand, cement, and gravel.

Protection of concrete after placing.—New concrete should not be exposed to the sun until after it has been allowed to harden for five or six days. Each day during that period the concrete should be wet down by sprinkling water on it both in the morning and afternoon. This is done so that the concrete on the outside will not dry out much faster than the concrete in the center of the mass, and it should be carried out carefully, especially during the hot summer months. Old canvas, sheeting, burlap, etc., placed so as to hang an inch or so away from the face of the concrete, serve very well as a protection when wet. Often the concrete forms can be left in place a week or ten days, thus protecting the concrete during the "setting-up" period, and the above precautions are then unnecessary.

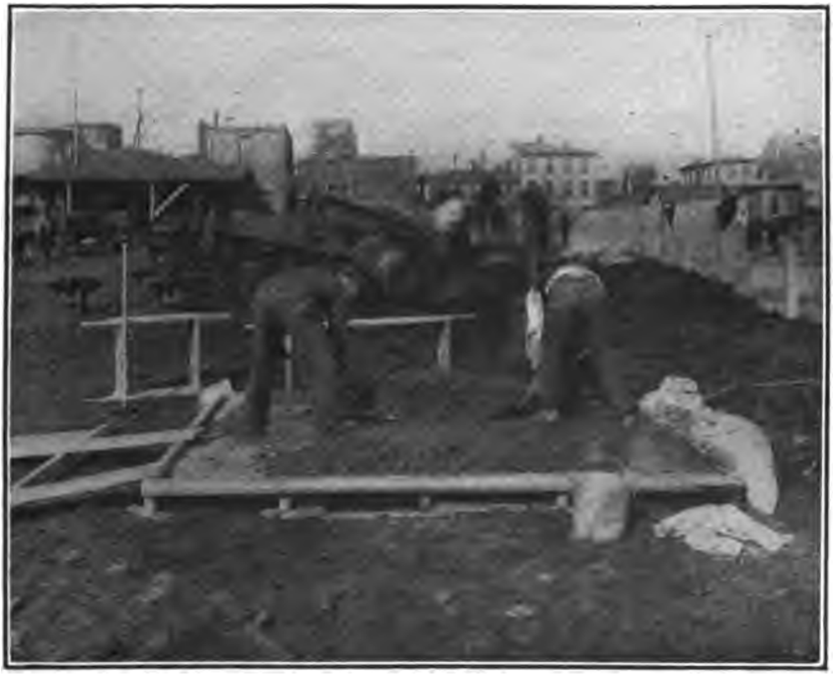

FIG. 10.—Final mixing of the concrete.

FORMS FOR CONCRETE.

Concrete is a plastic material and, before hardening, takes the form of anything against which or in which it is placed. Naturally, the building of the form is a most important item in the success of the work. These forms hold the concrete in place, support it until it has hardened, and give it its shape as well as its original surface finish.

Kinds.—Almost any material which will hold the concrete in place will serve as a form. Concrete foundations for farm buildings require shallow trenches, and, up to the ground line, usually the earth walls are firm enough to act as a form.

Molds of wet sand are used for ornamental work. Frequently colored sand is used for this purpose and provides both the finished surface and color to the concrete ornament.

Cast, wrought, or galvanized iron is used where an extremely smooth finish is desired without further treatment after the removal of the forms. Forms made of iron are more easily cleaned and can be used a greater number of times than those of wood. Rusty iron, however, should not be used. By far the greatest number of forms are made of wood, because of the fact that lumber in small quantities can always be obtained.

Requirements of a good form.—Forms should be well planned, so that there may be no difficult measurements to understand. As few pieces of lumber should be used for the work as possible, and these should be fastened together by as few nails as will serve the purpose; otherwise it will be difficult to take the forms apart without splitting them.

Forms must be strong enough to hold the weight of the concrete without bulging out of shape. When they bulge, cracks may open between the planks, and the water in the concrete, with some cement and sand, may leak out. This weakens the concrete and causes hollows in the surface, which have a bad appearance after the forms are removed.

Forms which lose their shape after being used once can hardly be used a second time. A part of the erection cost of forms is saved if the forms are built in as large sections as it is convenient to handle. This saving applies to their removal as well as their erection. Consequently the lightest forms possible with the largest surface area are the most economical.

Plans for forms.—The first consideration in planning forms is the use to which they are to be put. Neglect of this point means waste of money and time. If they are for work afterwards to be covered with a veneer coat, the finish of the surface is of small consideration, while the alignment of the form is all important. On the other hand, if a tank or retaining wall is to be built, the fact that the forms are not in exact alignment will hardly be noticed. Money can be saved, however, if the forms are rigid in alignment and well surfaced.

In planning forms for large structures it should be borne in mind that if the forms are to be used several times the more nearly perfect they are the more often they can be used and the cheaper they become. If forms are to be used only once, as is generally the case on the farm, they should not be nailed so securely as to prevent them from being readily taken apart and the lumber from being used for something else. It is often better to put them together with screws, but if nails are used, they should not be driven in all the way.

Selection of lumber for forms.—The selection of the lumber is of importance. If the forms are to be used many times, the use of surfaced lumber, matched, tongued and grooved, and free from loose knots, is economical. If, however, they are to be used only once, almost any plank will do. Forms with bad cracks or knot holes may be made tight by filling them with stiff clay mud and then tacking a strip over the crack and on the outside of the form.

Green lumber is preferable to kiln-dried or seasoned material. Seasoned lumber, when wet either by throwing water on the form before placing the concrete or by absorbing the water from the concrete, warps, and the shape and tightness of the form are damaged.

Originally only surfaced lumber was used for forms, and this was depended on to give a finish to the work, while to-day, since rough surfaces for concrete are the fashion, unfinished lumber may be used. Nevertheless, surfaced lumber has some advantages for use in forms. The forms fit together better and are easier to erect. They are more easily removed and cleaned. All of these items reduce the cost of the work, but the saving effected will, of course, depend on the difference in local price between finished and rough lumber.

Method of cleaning tools and forms.—At the beginning of the noon period and again at the end of the day's work all the tools, and especially the concrete board, should be carefully cleaned. Particles of concrete are also very apt to adhere to the forms. In order to prevent this the surface next to the concrete should be given a coat of oil or soft soap. Linseed, black, or cylinder oil may be used, but never kerosene.

Before erecting, the forms should be painted with an oil or soap and then carefully protected from dust or dirt until erected. If chips or blocks of wood fall inside the forms while erecting they must be carefully removed. Upon removal, the forms should be immediately cleaned of all particles of concrete adhering to the surface. A short-handled hoe will remove the worst, while a wire brush is most effective for finishing. In cleaning, care should be taken not to gouge the wood, because this spoils the surface of the next section of concrete. It will not be found necessary to repaint after each use, but it should be done whenever the surface appears dry in spots.

Concrete is a material for which there are many uses on the farm. Its successful use depends largely upon thorough mixing and careful placing. By following the methods laid down in this bulletin any farmer with his farm help may do much toward making his farm improvements both fireproof and permanent.

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Issued September 8, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 462.

THE UTILIZATION OF LOGGED-OFF LAND FOR PASTURE IN WESTERN OREGON AND WESTERN WASHINGTON.

BY

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AND

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1911.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., June 5, 1911.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript entitled, "The Utilization of Logged-off Land for Pasture in Western Oregon and Western Washington," prepared jointly by Mr. Byron Hunter, agriculturist, and Mr. Harry Thompson, expert, under the direction of the Agriculturist in Charge of the Office of Farm Management of this Bureau.

Respectfully,

WM. A. TAYLOR,
Acting Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE UTILIZATION OF LOGGED-OFF LAND FOR PASTURE IN WESTERN OREGON AND WESTERN WASHINGTON.

INTRODUCTION.

Western Oregon and western Washington for the most part are covered with dense forests of evergreen timber. For many years lumbering has been one of the leading industries of these two States. As a consequence the merchantable timber has been stripped from large areas, leaving what is known as "logged-off" or "cut-over" land. As left by the loggers the land is usually thickly studded with stumps of various sizes, among which old logs, tree tops, limbs, small timber, and underbrush are strewn. (See fig. 3.) To bring such land under cultivation is very expensive. In most instances the cost of the raw stump land plus the cost of clearing it exceeds the value of the land after it is under cultivation. For this reason the bulk of the logged-off land has been permitted to lie unimproved and unused since the timber was removed. In the meantime it has grown up to ferns, underbrush, and thickets of young evergreens. (Figs. 1 and 2.) In this condition cut-over land yields nothing to the owner and becomes a drawback to the community. During the summer months, when the logs, tree tops, and other rubbish on the surface of the ground become thoroughly dry, uncontrollable fires not infrequently sweep over these waste areas. In this way the logged-off land may become a menace to the adjacent standing timber and to the homes and property of the settlers who are making farms of these lands.

EXTENT OF LOGGED-OFF LAND.

At the present time there are approximately 3,000,000 acres of unimproved logged-off land in western Oregon and western Washington. The area of land of this description is also increasing very rapidly. In 1908 the 19 counties of Washington west of the Cascade Mountains had, in round numbers, a total area of 5,180,000 acres of standing timber. By 1910 this was reduced to 4,450,000 acres, a decrease of 365,000 acres per annum. A decrease in the area of standing timber means a corresponding increase in the area of logged-off land.

Logged-off land is being cleared and brought under cultivation very slowly when compared with the area stripped of its merchantable timber. In 1908 these 19 counties of western Washington had 432,000 acres of assessed cultivated or improved pasture land. This had increased by 1910 to 628,000 acres, an increase of approximately 98,000 acres per year. From these figures it will be seen, therefore, that the area stripped of its merchantable timber in western Washington exceeds that cleared and improved for pasture by 267,000 acres per year.

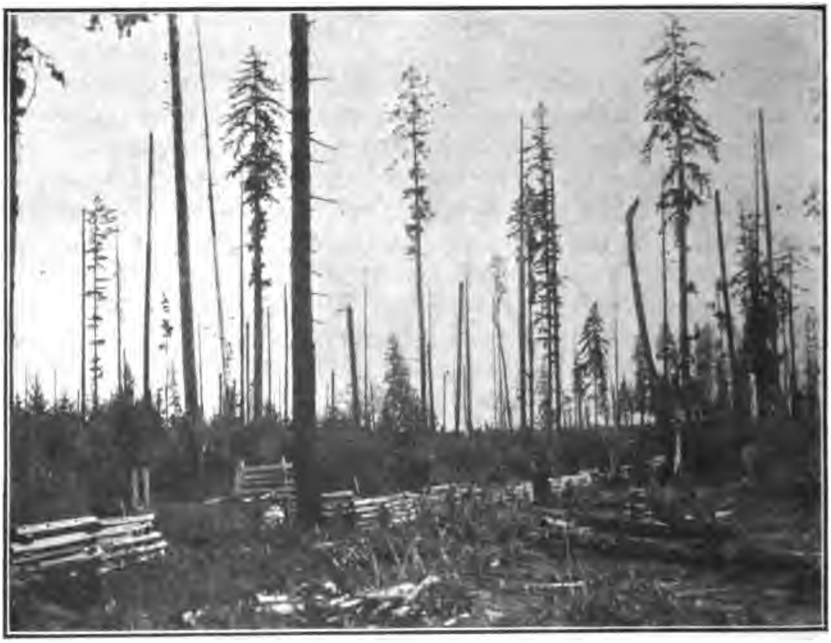

FIG. 1.—Logged-off land, showing its condition when used for pasture and the second growth produced when allowed to lie unused. The merchantable timber was removed from the land on each side of the fence during 1902. In the fall of 1905 the land was burned over. Orchard grass was sown in the ashes on the right side of the fence, but not on the left. Since the spring of 1904 the land to the right of the fence has been pastured with Angora goats, cattle, and horses. From a glance at the picture it will be seen that the cost of clearing the land that has been pastured would be much less than the cost of clearing that which has not been pastured.

UTILIZATION OF LOGGED-OFF LAND.

The rapid increase in population of both Oregon and Washington during the last decade has created a great demand for farm produce. To meet this it has been necessary to ship into these two States enormous quantities of food supplies. This necessity in turn has made a great market for farm land and has brought the question of utilizing logged-off land prominently before the people. In spite of the high cost of clearing cut-over land the great demand for farm produce is causing the fertile creek and river bottoms and much of the bench land adjacent to the cities and transportation points to be cleared and devoted to market gardening, truck farming, dairying, poultry raising, fruit growing, and general farming.

As the merchantable timber becomes scarcer and logging operations are crowded farther and farther back into the mountains, large areas of very rough land will be logged over. Perhaps the most satisfactory way to use such land is to burn it over after the merchantable timber is removed and then allow it to reforest itself. Steep hillsides are also to be found here and there throughout the logged-off areas which should be reforested. In future years when all of the cut-over land that is suitable for cultivation has been cleared, these steep hillsides, if allowed to produce a growth of evergreens, will not only be valuable for the timber produced but will add much to the attractiveness of the country.

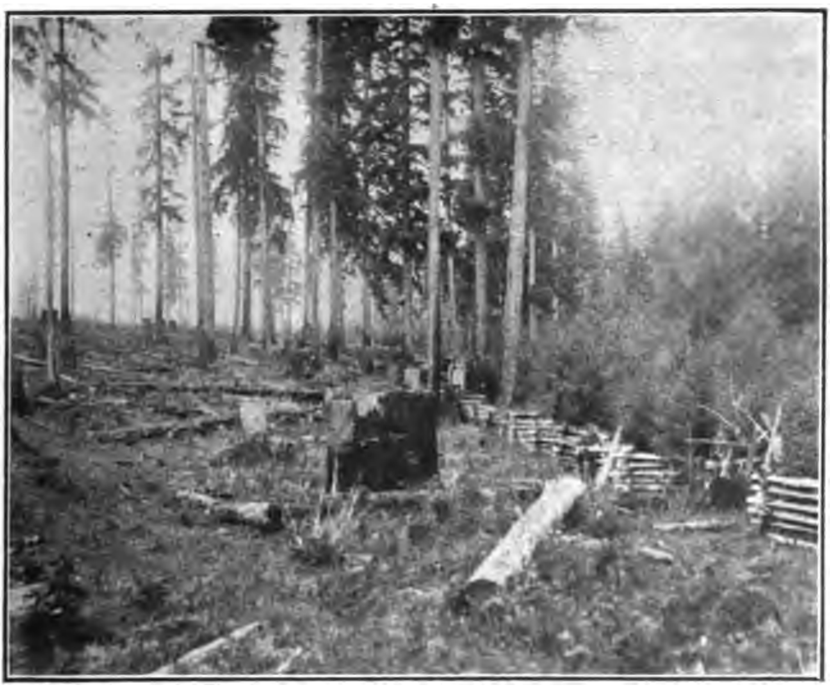

FIG. 2.—Logged-off pasture land that lay idle for eight years before being converted into pasture. The land on each side of the fence was logged over in 1895. A second growth of young trees and brush was permitted to spring up during the next few years. The second growth on the left of the fence was slashed (cut down) in the spring of 1903. During the following September the slashing was burned and 10 pounds of orchard grass seed per acre were sown in the ashes. Since the spring of 1904 the pasture has been grazed with Angora goats, cattle, and horses. The underbrush and young trees on the right of the fence represent a growth of 15 years. It will be clearly seen that the land on the left of the fence, which has been used for pasture for seven years, can be cleared and brought under cultivation much more cheaply than that on the right side of the fence.

Between the land that is now being cleared and brought under cultivation and the rough land that should be reforested lies the bulk of the present and future logged-off land. Eventually the most of this will doubtless be cleared and cultivated. Owing to the rapidity with which the timber is being cut and the slowness with which the logged-off lands are being cleared, it is very evident that it will be many years before the bulk of this land will be brought under cultivation. If allowed to lie unused it produces a growth of underbrush and evergreens. It therefore becomes more difficult to clear the land as the years go by.

The climate of western Oregon and western Washington is well adapted to the growing of grass and clover, and the primary object of this bulletin is to show (1) how these logged-off lands may profitably be used for pasture and (2) how, under proper management, this use will materially reduce the cost of clearing the land and decrease the danger of forest fires.

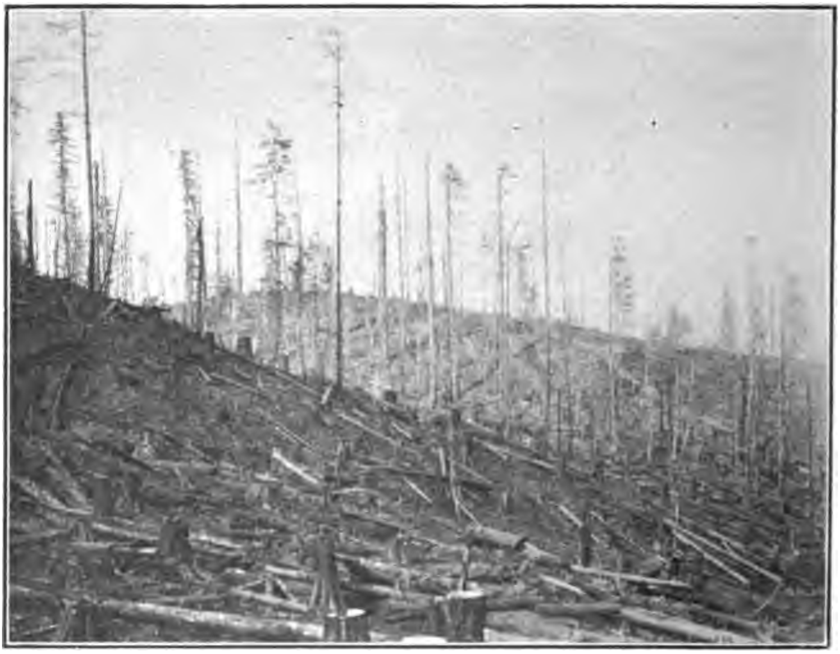

FIG. 3.—Burned-over logged-off land, showing the débris left by the loggers and the fire. The merchantable timber was removed during March and April, 1910. In July the land was burned over.

PREPARATION OF LOGGED-OFF LAND FOR PASTURE.

Under the usual modern methods of logging an enormous quantity of débris is left on the surface of the ground, in which fires frequently break out during the dry season. In order to protect the standing timber, it has become quite generally recognized that logged-off land should be burned over when the conditions are such that the fire can be kept under control. A typical area exemplifying the débris that is left after the land has been burned over is shown in figure 3.

TIME TO BURN.

Considerable difference of opinion exists regarding the most desirable time to burn. On the one hand the timbermen, who look largely to the protection of the standing timber, generally favor burning about the first of October or during May, i. e., at a time when fire will not run in the standing timber. While burning during the late fall or spring affords considerable protection from forest fires, it is well understood that a thorough, complete burn is seldom possible at that time. On the other hand, those who intend to clear the land or improve it for pasture almost universally favor burning during the last of August or early in September, just before the fall rains begin. At this season of the year everything is dry, and the fire consumes the greatest possible quantity of the coarse material. The fire also runs in the fine material lying on the surface of the ground, burns over the greatest possible area, and leaves a bed of ashes in which the grass seed may be sown. An excellent bed of ashes is shown in figure 4. If the land is burned over during the dry season it is necessary to obtain a permit from the State fire warden and to use much greater precaution for keeping the fire under control.

PREPARING FOR THE BURNING.

In order to get the greatest amount of pasture from logged-off land it is sometimes necessary to slash (cut down) the second growth of timber and brush that springs up after the logging. This second growth is shown in figures 1, 2, and 4. While evergreens may be slashed at any time during the year, deciduous trees and saplings should be cut in the late spring or early summer, when the leaves are out and the sap is flowing. If cut at this season of the year more of the roots will die and rot out. The slashing should be done early enough to give the brush time to dry. In order to get it to lie closely together and make the hottest fire when burned, the trees and brush should be felled in the same direction as nearly as possible. Cutting the large limbs from the tree tops left by the loggers will also aid in getting a complete burn. If the large and partly decayed logs are bored, split with a small charge of powder, and allowed to dry for several weeks they will be more nearly consumed by the fire. To guard against the fire being carried by the wind, the old dead trees and snags should be cut down. While this preparation for the burn is necessary in order to get the greatest quantity of feed from the pasture, some men claim it will not pay to do any slashing between the cessation of logging and the time of the burn. This is a matter that must be decided by each individual.

Since the land to be burned over is to be used for pasture, it will be necessary to fence it. If a fence row 10 or 12 feet wide is cleared around the margin of the area to be burned over, it will greatly help in controlling the fire. It will also make it much easier to keep the fence in repair when the land is inclosed. As a further precaution, several barrels of water may be hauled and placed at points where the fire is likely to be difficult to control.

TIME TO SET THE FIRE.

The velocity of the wind is usually highest from 10 a. m. to 5 p. m. The safest time to start the fire, therefore, is in the late afternoon or after the sun has gone down. It is safest to back-fire, that is, to start the fire on the side toward which the wind is likely to blow, forcing it to burn against the wind.

If logged-off land is burned over as indicated above—just before the fall rains begin—the ground is usually left in good condition for seeding. If the burn takes place during October or in the late spring, the fine trash on the surface of the ground is usually too wet to burn sufficiently to give a good stand of grass. The surface of the ground must be completely burned over and covered with ashes in order that the seed may germinate well. Figure 4 shows how completely the land may be burned over.

PASTURE PLANTS.

Since the stumps and the unburned tree tops in most instances will remain on the land for several years, there will be little opportunity to renew the stand of grass. For this reason great care should be exercised in selecting the seed for the pasture mixture. The ground will be occupied either by the grasses sown or by weeds. It is evident, then, that a part of the mixture should consist of plants which will start easily, make a rapid growth, and occupy the ground quickly. An excellent stand of grass on logged-off land is shown in figure 5. Because of the difficulty in renewing the stand it is also essential that the mixture contain plants which will last a long time, stand trampling and close cropping, and yet produce as much growth as possible. As a guide in making up the mixture, a brief description of the leading pasture plants is here given.

TIMOTHY.

Timothy is one of the most widely grown grasses in western Oregon and western Washington. The seed is cheap, has a very high percentage of germination, and usually gives a good stand if it has been properly sown. It thrives best on moist soil, not being well adapted to either very wet or very dry conditions. Timothy is an excellent grass to sow in temporary pasture mixtures and to occupy the ground for two or three years in permanent pastures. It should form only a part of the mixture on logged-off land, for it will gradually disappear and give way to weeds or more persistent, longer lived pasture plants. When sown alone, from 6 to 12 pounds of seed per acre are sufficient.

ORCHARD GRASS.

Orchard grass thrives remarkably well on most soils west of the Cascade Mountains and has given excellent satisfaction with those who have tried it as a pasture grass on logged-off land. It is one of the first grasses to begin growth in the spring, remains green well during the summer, makes a good growth during the fall, and thrives under the semishade of open woods better than most other grasses. It revives quickly after it is cropped by stock, stands grazing and trampling much better than timothy, produces a large number of basal leaves, and is one of the long-lived grasses. Orchard grass is relished fairly well by all kinds of stock until the stems begin to mature, when they get coarse and woody. While it is eminently adapted for grazing, it should form only a part of the pasture mixture because it grows in bunches and does not occupy all the ground. From 20 to 25 pounds of seed per acre are used when sown alone.

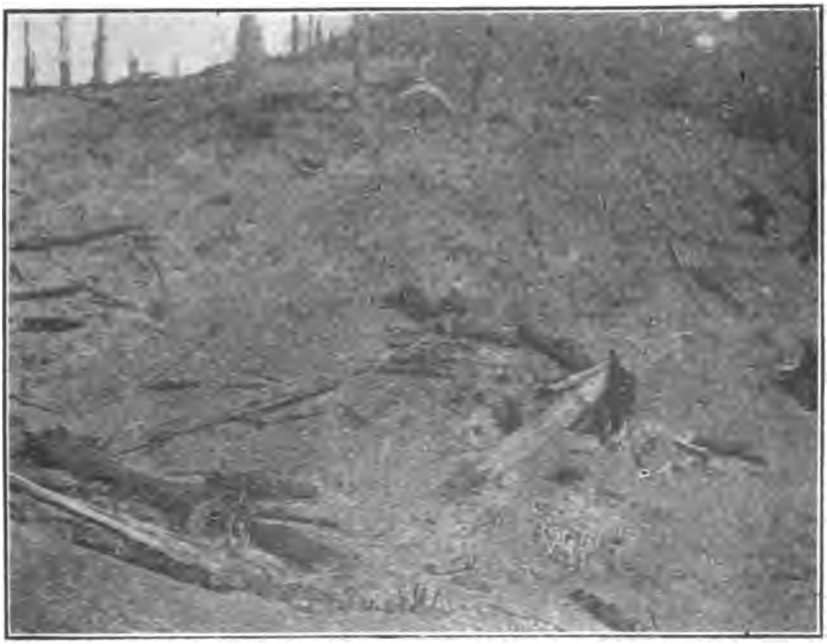

FIG. 4.—A good bed of ashes in which to sow grass seed; the result of slashing and burning a growth of brush 20 years old. The second growth is shown at the right.

ITALIAN RYE-GRASS.

Italian rye-grass is well adapted to the climatic conditions of the Pacific coast west of the Cascade Mountains. This is clearly shown by the rapidity with which it has spread over this region during the last few years. The seed of this grass is usually of good quality. It germinates well and the plants make a rapid growth from the seed in the fall of the year. One of its chief points of value is the rapidity with which it occupies the land and shuts out weeds. It also is one of the first of the grasses to begin growth in the spring and one of the last to stop growing in the fall. While it does not grow very tall, it makes considerable forage, owing to its dense basal foliage. It forms a close sod and stands cropping and trampling well. It is very palatable and stock prefer it to most other grasses. Under dry conditions Italian rye-grass is considered short lived, but in the moist climate west of the Cascade Mountains it is very tenacious and maintains itself remarkably well, except on the drier soils.

Italian rye-grass is very much like English rye-grass, from which it may be distinguished by the short beards on its spikelets. It also makes a quicker, larger, and more vigorous growth than English rye-grass. While Italian rye-grass may be grown under a wide range of conditions, it does best on moist, fertile soil. From 25 to 40 pounds of seed per acre are used when sown alone.

KENTUCKY BLUEGRASS.

Kentucky bluegrass is one of the best known permanent pasture grasses in the United States. It has creeping rootstocks which fill the surface soil and form a close, dense turf when the grass has become well established. Its density of sod makes it a desirable grass to sow on steep hillsides where the trampling of the stock will be severe. Bluegrass is very slow in establishing itself, and it usually requires three or more years to take possession of the land. For this reason such grasses as Italian rye-grass, timothy, and clover should always be sown with it. It is one of the few pasture grasses, however, that improves with age. Bluegrass is not adapted to very wet or to very dry soils. It makes a good growth in the spring and fall after the autumn rains begin, but it is practically dormant during the dry summer unless grown on moist soil. Owing to its means of spreading by rootstocks, close grazing when the plants are young does not injure Kentucky bluegrass as much as it does many other grasses. Its palatability, its longevity, its tenacious hold upon the soil, and its close, dense turf make it a very desirable grass to sow on logged-off land when it is known that the land will not be cleared for many years.

REDTOP.

Redtop is well adapted to poorly drained soils. It thrives on land that is too wet for timothy and Kentucky bluegrass. Although it is probably as little relished by stock as any of the pasture grasses, it should form an important part of the pasture mixture for extremely wet land. Since it has the habit of spreading by underground stems or stolons, it forms a firm sod that bears grazing and trampling well. Redtop is a very tenacious, hardy, long-lived grass when grown under conditions suited to it. The seed of redtop is sold in two forms, in the chaff and as recleaned seed. The recleaned seed has most of the chaff taken out. When sown alone, from 10 to 20 pounds of clean seed are used per acre. When the seed is in the chaff about twice this quantity must be used.

RED CLOVER.

West of the Cascade Mountains red clover thrives best on the rich, well-drained upland soils. It begins to grow in the early spring and furnishes the maximum quantity of forage during the late spring and early summer. Unless grown on moist soil its growth is retarded by the dry summer season. It begins to grow again with the coming of the autumn rains and generally furnishes excellent feed until December. In parts of western Oregon and western Washington red clover frequently runs out in a short time. This is largely due to the work of the clover root-borer, an insect that works in and destroys the roots of the plants. While the seed germinates well and it is comparatively easy to get a good stand under favorable conditions, red clover should be sown with the expectation of its lasting for only two or three years. When sown alone, from 8 to 12 pounds of seed are used per acre.

ALSIKE CLOVER.

Alsike clover is best adapted to soils which remain moist during the summer months. It grows very successfully on land that is too wet for red clover. In fact, it is capable of enduring a great deal of flooding, especially if the water is moving. While alsike also disappears in a few years unless reseeded, it is hardier, less susceptible to the attacks of the clover root-borer, and longer lived than red clover. Its chief place of usefulness in pasture mixtures on logged-off lands is on the very moist or wet soils. The seed of alsike clover is quite small, and 5 to 6 pounds per acre are generally used when sown alone.

WHITE CLOVER.

White clover is one of our most valuable pasture plants. It does best on moist soil west of the Cascade Mountains, but grows under almost all conditions, wet or dry, shade or sunshine. It is very easy to start and, unlike other clovers, is long lived. Although seldom sown alone, except on lawns, it is widely distributed throughout western Oregon and western Washington. The stems of white clover are inclined to be recumbent, often lying prostrate on the ground. At frequent intervals roots are produced on the stems when they are in contact with the soil. Owing to its creeping, prostrate habit, white clover forms a pretty close sod and is therefore well adapted to sow with plants like orchard grass, which grows in bunches. The seed is small; if sown alone, from 5 to 6 pounds per acre are sufficient. Because of the desirability of having a clover in the pasture and because of its longevity and ability to stand close grazing and trampling, white clover should form a part of every permanent pasture mixture.

PASTURE MIXTURES.

The plants which make up the pasture mixture should be determined very largely (1) by the condition of the soil; that is, whether it is wet, moist, or well drained, and (2) by the life of the pasture, whether permanent or temporary. The following mixtures are suggested. The numbers indicate the quantity of seed in pounds to the acre for each kind of grass in the mixture.

Mixtures of pasture grasses suggested for different types of land, showing the number of pounds of seed to the acre for each kind of grass in each mixture.

For wet land.	For moist land.	For upland.	
		Permanent.	Temporary.
Italian rye-grass, 8. Redtop, 4. Timothy, 3. Alsike clover, 3. White clover, 1.	Italian rye-grass, 6. Orchard grass, 4. Kentucky bluegrass, 4. Timothy, 2. Red clover, 4. White clover, 1.	Italian rye-grass, 8. Orchard grass, 5. Kentucky bluegrass, 4. Red clover, 4. White clover, 1.	Italian rye-grass, 8. Timothy, 3. Orchard grass, 5. Red clover, 5. White clover, 1.

Since Italian rye-grass, timothy, and alsike clover are all quick-growing plants, they will form the principal forage on wet land for the first few years. If not reseeded, alsike clover will disappear in three or four years and the timothy will gradually become thinner. Redtop, white clover, and Italian rye-grass will eventually form the chief herbage. A good stand of grass on logged-off land is shown in figure 5.

In the mixture for moist land Italian rye-grass, timothy, and red clover furnish the bulk of the feed for a few years, after which the timothy and red clover will disappear. Orchard grass, Kentucky bluegrass, and white clover will gradually gain possession of the land and furnish the larger part of the forage.

The permanent mixture for upland is intended for areas that will not be cleared for many years. Red clover and Italian rye-grass are the quick growers of this mixture, while orchard grass, Kentucky bluegrass, and white clover are the enduring, long-lived plants. White clover and Kentucky bluegrass will form a good turf that will stand much trampling and close cropping. Red clover will soon disappear, and for this reason many would omit it from the mixture. However, the abundant growth it makes for two or more years should be ample reason for sowing it. White clover will usually come of its own accord in a few years, and many who have had experience with logged-off land think it unnecessary to add it to the mixture. The importance of having a clover well distributed over the pasture, however, should justify sowing a small quantity of white clover seed.

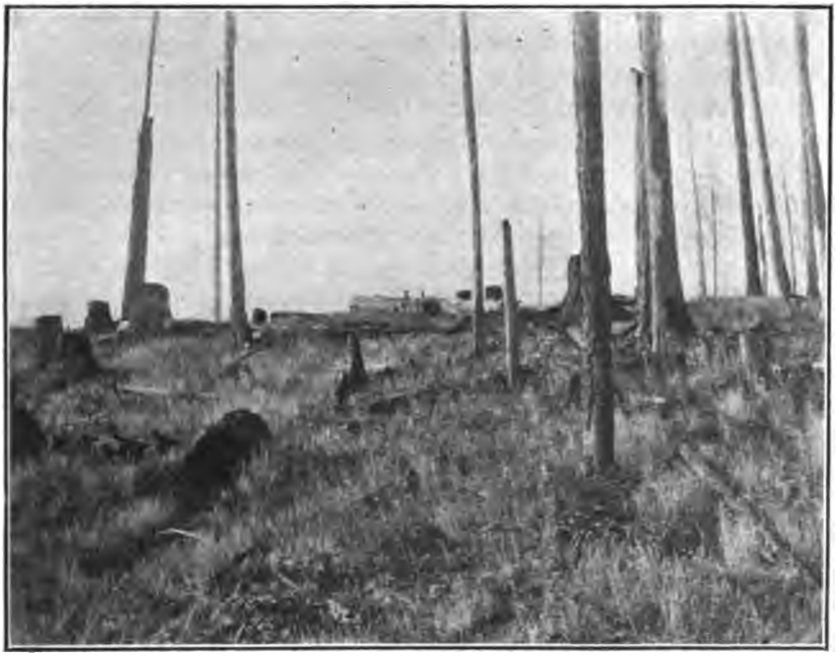

FIG. 5.—A good stand of grass, the result of sowing seed in the unsettled ashes. This land was burned over during the summer of 1909 and seeded that fall. The grass in the foreground is mostly Italian rye-grass.

The temporary mixture for upland is intended for areas that will be pastured with Angora goats for a few years to kill the brush before the land is cleared. Since it will require four to eight years to destroy the brush and rot the roots enough to permit plowing the land, it is necessary to place orchard grass and white clover in the mixture.

Of the grasses here recommended, Italian rye-grass and orchard grass are very popular with those who have tried them. Dr. D. F.

Francis, manager of the Chehalis River Lumber Co., has been seeding logged-off land for eight years. He has tested most of the common grasses and clovers and now has 1,700 acres seeded. He recommends Italian rye-grass, orchard grass, and white clover for the uplands and Italian rye-grass, redtop, and white clover for the wet soils.

WHEN TO SOW THE SEED.

The time of seeding will depend upon when the land is burned over. If the burn occurs during July, August, or early in September the seed should be sown in the early fall before the ashes have been settled by the rains. If seeded in the unsettled ashes, the first rains that come will cover the seed sufficiently to insure good germination. This usually gives excellent results. (See fig. 5.)

If the burn occurs so late in the fall that the seed can not be sown until during October, it is best to sow the grasses then and wait until in February or March to sow the clover. The heaving of the soil during the late fall and winter, a condition caused by alternate thawing and freezing, often destroys young clover unless it is sown early enough in the fall to get a good start. If the fall-sown clover is destroyed in this way it may be reseeded during February or March. When sown in the early spring the heaving of the soil helps to cover the seed.

MANAGEMENT OF THE PASTURE.

Because of the difficulty of renewing or improving the stand of grass, logged-off pasture land should be so carefully managed that it will remain in a high state of productiveness for many years. The pasture should not be closely grazed for at least two reasons. In the first place, live stock do poorly when the feed becomes scarce, and unless thrifty are seldom profitable. In the second place, close grazing materially lessens the quantity of feed produced and shortens the life of the pasture. Pasture plants must be allowed to produce plenty of green leaves if they are to be strong and vigorous, for the green leaves have been rightly styled the "digestive organs of the plant." Close grazing weakens and finally destroys the most of our pasture plants and gives weeds a chance to come in and occupy the ground. It is apparent, then, that pastures should be allowed to get a good start before the stock are turned in. Especially is this true if the pasture is new. Land that is sown in the early fall usually has not made sufficient growth to be grazed until late the following spring.

Experience has thoroughly demonstrated that pastures are most successfully managed when well fenced and divided into a number of fields. This makes it possible to restrict the stock to any inclosure and to change them from one pasture to another as the feed becomes plentiful or scarce. By changing the stock in this way the grass has a chance to become renewed in growth and freshness.[1]

WINTER FEED.

While the climate west of the Cascade Mountains is such that stock may be pastured during practically the entire year, stockmen must count on doing some winter feeding. Hay for the winter may be produced in two ways: (1) The logs, tree tops, and other rubbish left by the fire may be piled and burned and the land seeded to grass. Hay for winter feeding may then be cut from among the stumps. Hay is not infrequently produced in this way by the small farmers until they are able to clear the land of the stumps. (2) Enough land may be entirely cleared and put into cultivation to produce the required winter feed. It is usually possible to find moist, fertile areas of land here and there which may be cleared and used for this purpose.

The necessity of winter feeding may be greatly reduced by providing good winter pasture. This is done by removing the stock early in the summer and allowing the pasture to produce the greatest possible growth of stems and leaves during the late summer and autumn months. When the grasses practically cease growing in the late fall, the stock are turned into the winter pasture to feed upon the growth made during the autumn. This necessitates a subdivision of the pasture. Some prefer to use the newly seeded land for winter grazing. In this case the burned-over area is seeded in the early fall and the pasture is not grazed until a year from the following December. This gives the plants a chance to produce seed during the first summer and to become deeply rooted and well established.[2]

STOCK TO PASTURE.

There are two important problems which must be taken into consideration in using logged-off land for pasture. The first is to prevent the underbrush, briers, and weeds from occupying the land and crowding out the pasture plants. The second is the difficulty of maintaining the pasture in a productive condition where the stumps and timber are to remain on the land. In deciding the kind of stock to be pastured these two problems should be carefully considered.

The first of these difficulties may be met satisfactorily by the use of Angora goats. By nature these animals are browsers. They thrive on weeds and the leaves, buds, twigs, and bark of brush, a class of vegetation that other domestic animals rarely eat. By their use the underbrush may be either held under control or completely destroyed.

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[1] For a further discussion of the management of pastures, see Circular 49, Bureau of Plant Industry, U. S. Dept. of Agriculture, entitled "Improvement of Pastures in Eastern New York and the New England States."

[2] For a discussion of forage crops that may be grown under cultivation, see Farmers' Bulletin 271, entitled "Forage-Crop Practices in Western Oregon and Western Washington."

If the primary object in pasturing Angora goats on logged-off land is to kill the underbrush in order to lessen the cost of clearing the land, they are confined to certain areas until the brush is destroyed. This will require from two to five years, depending upon the brush and how closely it is kept browsed. After the brush is killed it takes two to three years more for the roots to decay sufficiently for the land to be plowed. In order to destroy brush uniformly in this way it is often necessary to cut the saplings that are too large to be bent over or ridden down by the goats, for all of the leaves and twigs must be within their reach. After the brush has all been killed it is very probable that some other kind of stock will prove more profitable than Angora goats.

In some instances Angora goats are kept solely for the mohair produced and the increase of the herd. When this is the primary object, instead of clearing the land of the brush, it is desirable to keep the pasture in the best possible condition for goats. In order to do this they are changed from pasture to pasture or given a larger range so that the brush may not be browsed closely enough to be destroyed. If provided with shelter and a good brush pasture, that is, a pasture that was not used during the previous season, Angora goats require very little other feed during the winter. Proper care and suitable feed during the severest weather, however, will keep them more thrifty and increase the quantity and quality of mohair produced.

The second difficulty, that of maintaining the pasture in a productive condition, must be met very largely by carefully guarding against overgrazing and by pasturing the kind of stock that is least severe on the stand of grass. If the pasture is carefully managed, so that the brush will be kept under control instead of being killed, the land may be used as a goat pasture almost indefinitely, for the Angora goat eats very little grass when browse is plentiful.[1]

When the land is burned over and seeded as indicated above, a great deal of grass and clover will usually be produced, much more than goats will consume in connection with their browsing. Some other kind of stock may profitably be run with goats to consume this surplus feed. That both sheep and horses are more severe on pasture than cattle is well known. For this reason cattle as a class are the most satisfactory stock to pasture with Angora goats on logged-off pasture land. The rapidity with which the population of the Pacific Northwest has increased during the last decade has built up a strong demand for both beef and dairy products, especially the latter. The

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[1] For a fuller discussion of the care and management of the Angora goat, see Farmers' Bulletin 137, entitled "The Angora Goat;" also Bulletin 78, of the Washington State College, Pullman, Wash., entitled "The Goat Industry in Western Washington."

State of Washington is importing approximately $7,000,000 worth of dairy products per annum. In addition to the shortage in the production of dairy products in both Oregon and Washington, there is also a corresponding shortage in good dairy cows. There are few localities where dairy cows and dairy products can be produced more cheaply than in that portion of Oregon and Washington lying west of the Cascade Mountains. The moist, mild climate of this region makes it possible to graze cattle during the greater portion of the year, and there is no reason why the logged-off lands of western Oregon and western Washington may not be used successfully in this way.

SUMMARY.

There are approximately 3,000,000 acres of unimproved logged-off land in western Oregon and western Washington. The area of such land is increasing very rapidly.

Much of the logged-off land in both Oregon and Washington is well adapted to cultivation. Some of it is rough and should be reforested.

Owing to the high cost of removing the stumps it will be many years before the bulk of this land will be cleared and brought under cultivation. If allowed to lie unused the land usually produces a dense growth of underbrush and young trees. In this way the cost of clearing the land increases from year to year. (See figs. 1, 2, and 4.)

The moist, mild climate of western Oregon and western Washington is admirably adapted to the growth of pasture forage, and stock may be grazed during most of the year.

The underbrush may be kept under control or destroyed by properly utilizing these lands for pasture. When the brush is killed by the use of Angora goats, the cost of clearing the land is materially reduced. This is clearly shown in figures 1 and 2.

The use of logged-off land for Angora-goat pasture is a great protection against forest fires. This is also shown in figures 1 and 2.

Logged-off land is profitably used for pasture as follows:

(1) The land is burned over as completely as possible during August or early September, when everything is dry.

(2) Good stands of grass are obtained by sowing the seed in the loose ashes before the fall rains begin. (See fig. 5.)

(3) The pasture is divided into several fields in order that the stock may be shifted from one inclosure to another as the feed becomes scarce or plentiful.

(4) Winter pasture is provided by removing the stock from an inclosure in early summer. In the late fall the stock is turned in to graze upon the forage produced during the late summer and autumn. A good winter pasture lessens the necessity for winter feeding.

(5) Because of the difficulty of renewing or improving the stand of grass, owing to the stumps and tree tops remaining on the land, it is necessary to guard carefully against overgrazing.

(6) Because of the underbrush that persists in growing on uncleared land and because they feed largely on browse, Angora goats should be widely used on logged-off pasture land either to control or to kill the brush.

(7) When the land is properly burned over and seeded, more forage should be produced than the goats can consume in addition to their browsing. Some other kind of stock should be run with the goats to consume this surplus feed. Cattle are most satisfactory for this purpose.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 463.

THE SANITARY PRIVY.

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WASHINGTON
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1911.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 6, 1911.

To the farmers of the United States:

Nothing is more important to the farmer than good health. Good health can not be preserved if the sanitary conditions of the farm are bad. Among the worst conditions ever to be found about any home is a soil that has become polluted with excrement from the human body. A number of widely prevalent diseases have been spread by means of such polluted soil, simply because the facts have not been generally known. This bulletin treats of such soil pollution and certain simple plans for avoiding it.

Having at heart the best interests of the American farmer and his family, I consider it my personal duty to appeal to every American farmer to weigh well the facts here presented, to do all in his power to remove any insanitary conditions that he may find on his farm or in his neighborhood, and thus, by protecting the members of his family, perform one of his highest patriotic duties.

JAMES WILSON,
Secretary of Agriculture.

LETTER OF TRANSMITTAL.

United States Treasury Department,
Public Health and Marine-Hospital Service,
Washington, D. C., April 20, 1911.

Sir: With the approval of the Secretary of the Treasury, I have the honor to transmit herewith a manuscript entitled "The Sanitary Privy," prepared by C. W. Stiles and L. L. Lumsden, of the Hygienic Laboratory of this service. Professor Stiles is also consulting zoologist in the Bureau of Animal Industry, Department of Agriculture. For some years past these two officers have been making a special study of certain diseases which are particularly incident to farm life and of the methods by which these infections are spread, and their reports thereon have appeared in the publications of the Public Health and Marine-Hospital Service. These have been revised, and the manuscript, with the description of additional research work, is submitted, that it may become available through the Department of Agriculture to those living on farms, who naturally look to your department for such information.

Respectfully,

Walter Wyman,
Surgeon General.

Hon. James Wilson,
Secretary of Agriculture.

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463

THE SANITARY PRIVY.

SOIL POLLUTION.

It is common knowledge among intelligent farmers that in many instances when live stock, such as horses, cattle, sheep, or hogs, are pastured year after year in the same field, the animals do not thrive; in fact, that, sooner or later, many sicken and die; this is especially true of the young animals.

The explanation of this fact is clear. Animals harbor parasitic worms and germs in their intestines; the worms lay eggs, which are passed in the droppings; the eggs develop into young worms, which in turn reinfect the live stock. If a pasture is in constant use the ground becomes heavily infested with young worms and other germs; the smaller the pasture in proportion to the number of animals kept in it, the more intensified the soil pollution becomes. Warmth and moisture are especially favorable to the hatching out of worms from the eggs passed in the droppings, hence, during warm, moist seasons, or in warm, moist localities, the infection of the stock is likely to be more severe. The more heavily the animals are infected with parasites, the less they thrive; their digestion is weakened and their blood becomes watery, so that a considerable proportion of the food given them is wasted in that it does not go to make meat; their growth is retarded and their fertility is lessened; and finally infection reaches such a degree that many of the animals can no longer withstand it, and they sicken and die. Thus, the soil pollution of a field by the live stock eventually renders the pastures unfavorable for raising animals. The practical farmer, having observed this fact, moves his stock to other ground in order "to give the old pasture a rest;" by so doing he removes his animals from exposure to infection, allowing the infectious germs and young worms in the old pasture to die out.

The foregoing facts regarding the effects of soil pollution upon the health of animals, such as horses, sheep, cattle, swine, and chickens, apply with equal force to human beings, because human beings also harbor parasitic worms and germs, which are discharged in the excreta, pollute the soil, are again conveyed to people, and thus continue the round of infection at an increasing rate. Soil pollution by

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human excreta endangers the health of a family, just as soil pollution of a pasture by the droppings of animals endangers the live stock.

In order to prevent the evil effects of soil pollution from extending to his live stock, the farmer must resort to more or less expensive methods, such as purchase of additional pasture lands or burning the pasture. But since human beings, on account of their superior intelligence, can be taught to frequent an appointed place to deposit their excreta, it is possible (by the expenditure of a few dollars for a sanitary privy) to prevent soil pollution with human excreta, thereby protecting the family, and enabling it to live year after year on the same premises (family pasture) without danger, at the same time saving doctors' bills and avoiding unnecessary sickness and death.

DISEASES SPREAD FROM MAN BY SOIL POLLUTION.

It is especially the diseases caused by parasites (both animal and bacterial) of the intestine, lungs, liver, kidneys, and bladder that are spread by soil pollution. Some of these diseases are spread from human being to human being; others are spread from human beings to the farm animals. Therefore, in preventing soil pollution by persons, both families and live stock are protected.

The proper disposal of human excreta is recognized by sanitarians as the most important measure needed to prevent the spread of typhoid fever, hookworm disease, the dysenteries, and certain other widely prevalent diseases.

DISEASES SPREAD FROM MAN TO MAN.

Some of the diseases which come under this heading are caused by microscopic parasites known as bacteria; others by animal parasites, which are considerably larger than the bacteria.

BACTERIAL DISEASES.

Among the most important diseases under this heading may be mentioned typhoid fever, dysentery and diarrhea ("summer complaint"), and tuberculosis ("consumption").

Typhoid fever.—Every person who contracts typhoid fever does so because he has recently swallowed some typhoid germs that have been passed in the stools or urine of some other person, who either (as a patient) was suffering from typhoid or (as a "carrier") was carrying the germs without showing symptoms.

The germs (bacilli) of typhoid fever are of very minute size, a single germ (bacillus) being only about $\frac{1}{18000}$ of an inch in length and only about $\frac{1}{36000}$ of an inch in thickness. Like molds and yeasts, they are plants, and under favorable conditions (as in milk, for instance) they multiply at a very rapid rate, so that in a few hours a single germ may increase to thousands. Thousands of these little germs may be contained in a particle of feces no larger than the head of an ordinary pin, or in a small drop of urine, and hundreds may be carried on the leg of a fly (fig. 1). A person suffering from typhoid fever discharges myriads of these germs in the stools and urine. Therefore, the excreta from typhoid patients should be regarded as highly poisonous, and everything which may become soiled with the smallest quantity of feces or urine should be thoroughly disinfected by heat or chemicals.

After being discharged in the excreta from the bodies of persons, typhoid germs gradually die out, but the length of time during which they will survive in the excreta is affected by a number of conditions; in some instances they have been found to live for over a year in the contents of privies and privy vaults and in excreta mixed with earth. Therefore, excreta which have been passed through a septic tank or which have been stored for months in a privy or privy vault should not be regarded as being free from typhoid germs.

Persons in the early stages of typhoid fever, before becoming ill enough to take to bed (and some time perhaps before the physician is called in), may discharge typhoid germs in their excreta. Some persons contract infection and though having symptoms of the disease in a mild form ("walking cases of typhoid fever") never become ill enough to give up and take to bed. Other persons contract and harbor the infection for a few days or weeks without showing any symptoms whatever ("temporary typhoid-bacillus carriers"). In many instances the excreta from such persons are as heavily charged with typhoid germs as are those from persons suffering with the severest attacks of the disease. Some persons recovered from attacks of the disease continue to discharge typhoid germs in their stools or urine, or both, for weeks, months, or even years ("chronic typhoid-bacillus carriers"). In view of all these now thoroughly established facts, it is evident that to prevent the spread of typhoid infection from persons it is necessary to dispose properly of the excreta from all persons at all times. This can be done by the use of sanitary privies.

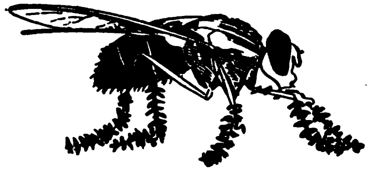
FIG. 1.—A fly with germs (greatly magnified) on its legs.

If the excreta are not properly disposed of it is readily understood that the germs may be carried in a number of ways to the water or food supplies, and then be swallowed by and cause infection in persons. They may be carried by drainage or seepage or tracked on the feet of persons, live stock, and poultry to the well or spring. They may be carried directly by flies from the excreta to the foods in the kitchen or dining room. If spread about the place they will from time to time get on the hands of persons, and thence into the water or foods.

Some of the ways in which typhoid germs in the excreta from infected persons may be conveyed to other persons are shown in the following diagram:

Diagram of modes of spread of typhoid fever.

$$\text{Excreta from}\ldots\left\{\begin{array}{c}\text{Typhoid}\\ \text{patients or}\\ \text{Typhoid}\\ \text{germ}\\ \text{carriers}\end{array}\right\}\text{to}\left\{\begin{array}{l}\text{Fingers}\ldots\\ \text{Flies}\ldots\\ \text{Water}\ldots\\ \text{Foods}\ldots\left\{\begin{array}{l}\text{Milk}\ldots\\ \text{Raw vegetables and}\\ \quad\text{fruits}\ldots\\ \text{Bread, cake, candy,}\\ \quad\text{etc}\ldots\end{array}\right.\end{array}\right\}\text{to}\left\{\begin{array}{c}\text{Mouths of}\\ \text{persons}\end{array}\right.$$

The foregoing diagram shows that the easiest way of protecting against typhoid fever is to dispose of the excreta in such a manner that the germs contained therein can not be spread. This can be done by using sanitary privies.

Dysentery and diarrhea ("summer complaint").—Dysentery and similar infections can be prevented in the same way as typhoid fever, as their method of spread is the same.

Tuberculosis.—Although the danger of spreading tuberculosis by spitting must be constantly held in mind, it is important to remember also that many tubercle bacilli may be discharged in the feces, because persons with lung tuberculosis ("consumption") frequently swallow their sputum, and also because some persons have tuberculosis of the bowels. The spread of tuberculosis by soil pollution may be prevented by using sanitary privies.

PARASITIC DISEASES.

Among the diseases caused by animal parasites, and spread by soil pollution from man to man, there may be mentioned, especially, hookworm disease, Cochin-China diarrhea, eelworm infection, pinworm infection, blood-fluke infection, amœbic dysentery, and many other diseases. In some of these maladies the infection is spread in much the same way as is that of typhoid fever, the germs being swallowed; in others the infection may take place through the skin. All of these diseases can be prevented by using sanitary privies.

Hookworm disease.—There are in this country at least 2,000,000 cases of hookworm disease. The parasites, which are about half an inch long, attach themselves to the wall of the bowels, which they wound, and from which they suck blood.

The worms lay eggs which are passed in the stools and which escape from the body in no other way. If the ground is polluted by the human excreta, this disease spreads, but if the excreta are deposited in a sanitary privy, and properly disposed of, the disease can be easily prevented.

Under favorable conditions, from these eggs, which are too small to be seen with the naked eye, hatch out within a few hours tiny worms; these worms grow and shed their skin, much like a snake; when about one to two weeks old, but still only about one-fortieth of an inch long and therefore scarcely visible to the naked eye, they may be swallowed, or they may burrow through the skin, especially of barefooted children, and cause that condition known as "ground itch," "dew itch," "dew sores," "toe itch," etc. Wherever "ground itch" exists, it is proof that somewhere in that locality soil pollution has occurred, because there is a privy which is either not properly built, or not properly taken care of, or not properly used, or because there is no privy at all.

From the skin these tiny worms get into the blood and gradually make their way to the bowels, where they grow to adult worms, and in their turn lay eggs.

If any member of the family or any person on the farm is pale, weak, or sickly, and has had "ground itch" within 10 years past, the family physician should be consulted as to whether the trouble is due to hookworms. In many of the States the State board of health will either make or have made a microscopic examination, free of charge, to determine the point definitely.

Although hookworm disease may have serious effects, even resulting in death, it can be easily cured at a slight expense, and it can be entirely eradicated if sanitary privies are built and used.

Cochin-China diarrhea.—This is a disease which is spread very much in the same way as hookworm disease. It is very difficult to treat successfully, but it can be absolutely prevented by the use of sanitary privies.

Eelworm infection.—The eelworms are about as large as a lead pencil, and are found among children. Whenever found they prove that there is something wrong with the sanitary conditions.

Amœbic dysentery.—This is a very serious disease. It may cause death, but its spread can be prevented by the use of sanitary privies.

PARASITIC DISEASES SPREAD FROM MAN TO LIVE STOCK AND THEN BACK TO MAN.

At least two kinds of tapeworms are spread from man to live stock and back to man because of lack of sanitary privies.

Beef-measle tapeworm.—This tapeworm, when harbored in the intestine of man, lays thousands of eggs, which are discharged in the stools, and if scattered about may be swallowed by cattle. Here they cause "beef measles," reducing the value of the beef. By eating measly beef man may become infected with this tapeworm.

Pork-measle tapeworm.—The eggs of this tapeworm are passed in the stools of man and swallowed by swine, in which they cause "pork measles." By eating such pork man may become infected with tapeworms. This tapeworm is especially dangerous, because if a person harbors it and pollutes the soil with his excreta containing the eggs, these eggs may be swallowed by persons and cause a serious disease known as "pork measles" in man, which may cause blindness, insanity, and death.

Both of these tapeworm infections can be prevented by the use of sanitary privies.

HUMAN EXCREMENT AS A BREEDING PLACE FOR FLIES.

Flies and many other insects feed upon and breed in filth, such as manure and human excrement. Whenever a fly is seen it is positive proof of the existence of some filth in the neighborhood. It is much more filthy and much more dangerous to have flies in the kitchen and dining room than to have bedbugs in the bedroom.

Flies can carry various disease germs to man. By so doing they kill thousands of people, especially babies, every year; therefore kill the flies and save the babies.

If flies have access to human excrement, they not only feed upon it, but they lay their eggs in it. After a few hours the egg hatches out a maggot; this feeds in the filth for several (about five) days and then forms a pupa; after about five days the adult fly comes out of the pupal case, feeds on the filth, and carries disease germs from the filth to the house, depositing these germs on the foods. Thus flies carry disease to people. A fly drops his excrement about once every 4½ minutes and may spread germs not only in this way, but also with his feet, wings, and mouth parts.

Even if excrement containing fly maggots is buried under as much as 6 feet of sand, the maggots can crawl to the surface, bringing disease germs with them.

Thus it is clear that if flies are kept away from human excrement, not only will they decrease in numbers, but they will be prevented from spreading certain diseases, such as typhoid fever. This can be done by the use of sanitary privies.

PRIVY CONDITIONS ON SOME AMERICAN FARMS.

The privy on the American farm possibly has not received the attention that its importance deserves. Some American farms have no privy at all. This means that some farm families are being needlessly exposed to sickness and death. It means that these families are following a custom which not only needlessly increases sickness and death, but which decreases the value and productiveness of their farms. The warmer, more moist, and more shaded the locality, the greater is the danger resulting from lack of sanitary privies.

City health authorities are gradually awakening to the dangers connected with the supplies of milk, fresh vegetables, and fresh fruits from insanitary farms; hence not only from the standpoint of preserving the health of persons living on farms and increasing the productiveness of the farms, but also from the standpoint of marketing farm produce, it is important for farms to be provided with sanitary privies.

DIFFERENT KINDS OF PRIVIES.

The popular idea of the purpose of a privy.—To the popular mind a privy (as indicated by its name) is a structure to which a person may retire in private when responding to the daily calls of nature. In the minds of most persons modesty and privacy are the chief considerations which lead to the construction of a privy. As such privacy may be secured by a clump of bushes or a grove of trees, some persons consider a privy unnecessary.

Modesty and privacy are laudable objects, but all must agree that they are of infinitely less importance than the great object of saving human life by preventing the spread of disease.

The essential parts of a privy.—A privy should consist of two chief parts, namely: First, a receptacle for the excreta; secondly, a room to insure privacy.

The essential problems in constructing a privy.—From the foregoing it is clear that the two great problems to be held in mind in constructing a privy are: First, to protect the receptacle for the excreta in such a way that the germs can not be spread; secondly, to construct the entire outhouse in such a way that persons will seek to use it and not to avoid it—in other words, not only must it insure privacy, but it must not be a disagreeable place in which to be private. This latter point is especially important in warm climates, for many a privy is so disagreeable in warm weather that people, especially men, very frequently avoid it. Still another point must be considered, namely, the cost of construction and maintenance must be brought within the purse limits of the poor as well as of the well-to-do family.

The kinds of privies that are not sanitary.—If the excreta are scattered broadcast, the infection they contain is also scattered far and wide. If the excreta are deposited in one place, the infection they contain is more restricted. Therefore, any kind of privy is better than none. From a faulty privy, however, much infection may be spread in various ways, as, for instance, by drainage and seepage, or by chickens, swine, and dogs, or by the feet of persons, or by insects, especially flies.

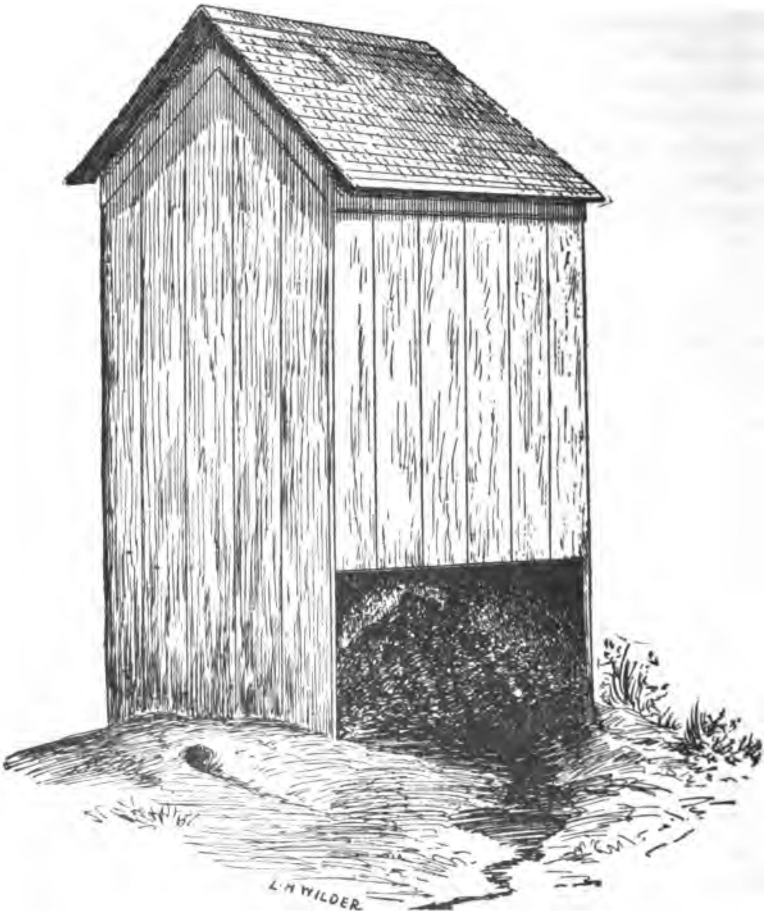

FIG. 2.—An insanitary privy, open in back. (Stiles, 1910.)

Figure 2 represents a dangerous type of privy. On a systematic rating it should not be marked higher than 10 on a scale of 100, therefore it is 90 per cent below perfect. The protection afforded by this privy depends in great measure upon the frequency with which the excrement is removed. But even if this privy is cleaned every day, chickens, hogs, and flies have access to the fresh night soil for a number of hours, and, besides that, the ground under and around the outhouse becomes polluted.

Even if such a privy is provided in the back with a tightly fitting trapdoor, so as to exclude domesticated animals and to prevent the toilet paper from being blown about, its efficiency is increased by only about 15 points, so that it should not be ranked more than 25 on a scale of 100. Insects, such as flies, ants, and roaches, still have access to the night soil, which also pollutes the ground under and around the privy.

The kinds of privies that are sanitary.—A sanitary privy must meet the following requirements:

(1) The excreta must not touch the ground; hence some kind of water-tight receptacle (box, pail, tub, barrel, tank, or vault) for the excreta must be used under the seat.

(2) Domesticated animals must not have access to the night soil; therefore the privy should have a trapdoor in the back to exclude them.

(3) Flies and other insects must not have access to the excreta; therefore the entire privy must be made rigidly flyproof, or some substance must be used in the receptacle to protect the contents from insects.

Two types of sanitary privies are generally recognized, namely, the so-called "dry system" and the so-called "wet system."

THE "DRY SYSTEM."

In the "dry-system" privies dry earth, road dust, wood ashes, or lime is kept in the privy, and is scattered on the excreta every time the privy is used.

The dry system, if properly managed, presents the following advantages:

(1) It decreases the offensiveness of the privy contents.

(2) It is cheap.

(3) It decreases the chance of spread of infection by insects.

(4) It is an easy system to manage.

The disadvantages of the dry system are the following:

(1) It is very difficult to make a dry privy rigidly fly proof, hence flies usually do have more or less access to the excreta, on which they feed and on which they lay their eggs.

(2) Its efficiency depends upon the careful and faithful cooperation of all persons (including children) who use the privy, and experience shows that such cooperation can not be relied upon.

(3) It increases the amount of material to be removed; hence it increases the labor and frequency of necessary cleaning.

(4) Experience shows that it is exceptional that the excrement is properly covered with dry earth or lime; hence the system is not so efficient as is popularly supposed.

(5) Neither dry earth nor lime, in practical usage, can be relied upon to destroy all disease germs which may be in the excreta; hence their use is likely to give rise to a false sense of security in the public mind.

(6) If the dejecta at the time of burial contain fly grubs these larvæ may crawl through the earth to the surface, where they can complete their development into adult flies and spread infection from the buried night soil.

Privies of the "dry system" should not be marked more than 75 points on a scale of 100.

Figures 6 and 7 (pages 22 and 23) represent an outhouse which may be used as a dry privy.

THE "WET SYSTEM."

In the "wet-system" privies some fluid is used in the receptacle either (1) to disinfect the excreta, or (2) to act as an insect repellent, or (3) to increase the destruction of disease germs in the excreta by natural fermentation. Figures 6 and 7 represent outhouses which can be used as "wet-system" privies.

The advantages of the "wet system," when applied to outhouses shown in figures 6 and 7, are:

(1) It decreases the offensiveness of the privy contents.

(2) It is cheap.

(3) It greatly decreases the chances of spread of infection by flies because they can not breed in the excreta; hence rigid fly screening is not so necessary.

(4) It kills or renders harmless a considerable proportion of certain infections contained in the excreta.

(5) Its efficiency does not depend upon the intelligence or cooperation of all persons using it.

The disadvantages of the "wet system," as applied to outhouses shown in figures 6 and 7, are:

(1) It is more difficult to keep clean than the "dry system," because of the danger of soiling the floor when the receptacle is emptied.

(2) Unless the receptacle is very deep there is likely to be more or less splashing.

(3) The labor and frequency of cleaning are about the same as in the case of the "dry system."

If the wet system is used it is best to fill the receptacle about one-fourth full of water, on the surface of which a cup of petroleum is poured. The petroleum acts as an insect repellent.

Two sets of receptacles should be provided. While one set is being used under the seat, the other set is covered and permitted to stand so as to lengthen the period of fermentation.

THE L. R. S. PRIVY.[1]

On account of the various objections raised against the different styles of privies now in use, an effort has been made to construct a device which will decrease the disadvantages and at the same time increase the advantages connected with the older types of outhouses. The results obtained from various experiments have been applied to an apparatus known as the L. R. S. privy (figs. 3, 4, and 5).

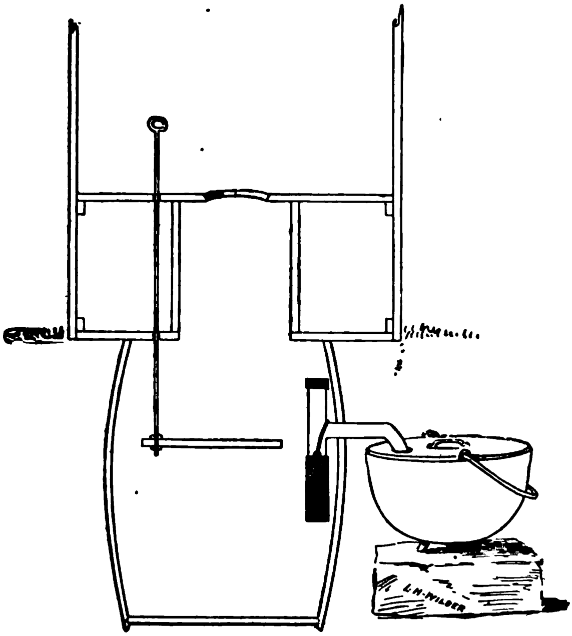

FIG. 3.—Improved L. R. S. privy.

This apparatus consists of the following parts:

(1) A water-tight barrel or other container to receive and liquefy the excreta.

(2) A covered water-tight barrel, can, or other vessel to receive the effluent or outflow.

(3) A connecting pipe about 2½ inches in diameter, about 12 inches long, and provided with an open **T** at one end, both openings of the **T** being covered with wire screens.

(4) A tight box, preferably zinc lined, which fits tightly on the top of the liquefying barrel. It is provided with an opening on top for the seat, which has an automatically closing lid.

(5) An antisplashing device consisting of a small board placed horizontally under the seat about an inch below the level of the transverse connecting pipe; it is held in place by a rod, which passes through eyes or rings fastened to the box, and by which the board is

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[1] Lumsden, Roberts, and Stiles: Preliminary note on a simple and inexpensive apparatus for use in safe disposal of night soil. Public Health Reports, 1910, Nov. 11, v. 25 (45), pp. 1619–1623, fig. 1.

raised and lowered. The liquefying tank is filled with water up to the point where it begins to trickle into the effluent tank.

As an insect repellent a thin film of some form of petroleum may be poured on the surface of the liquid in each barrel.

Practical working of the apparatus.—When the privy is to be used, the rod is pulled up so that the antisplashing board rises to within about 1 inch below the surface of the water. The fecal material falls into the water, but this board prevents splashing, and thus overcomes one of the greatest objections thus far raised to the wet system. After use, the person sinks the antisplashing board by pushing down the rod, and the fecal matter then floats free into the water.

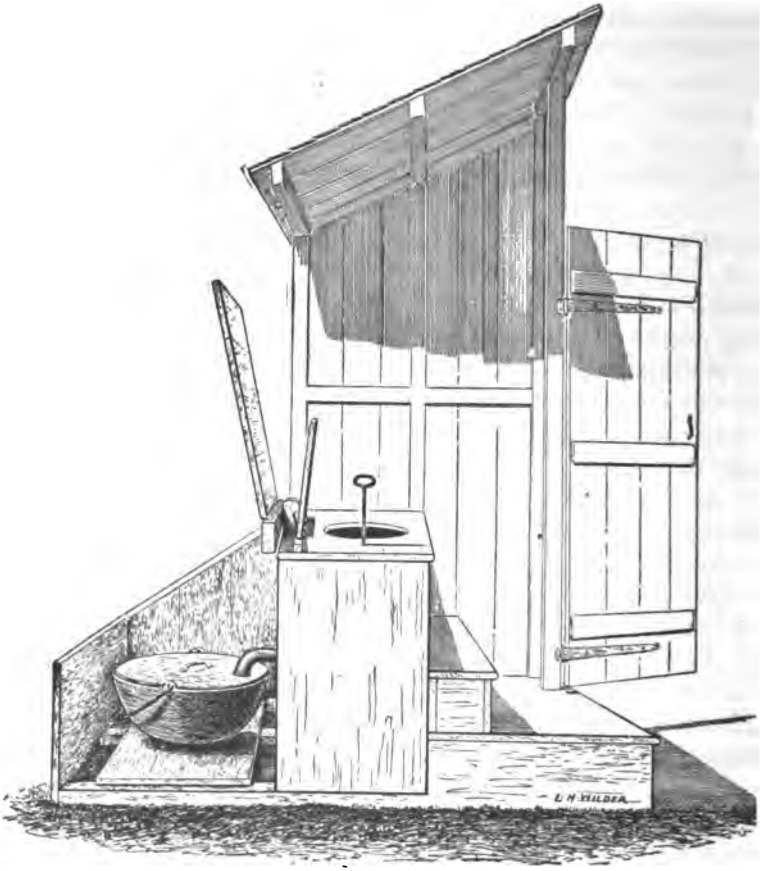

FIG. 4.—Inside view of L. R. S. privy.

Although some of the fecal matter floats, it is protected both from fly breeding and fly feeding in the following ways: First, by the automatically closing lid; second, by the water; third, by the film of oil; and, fourth, by having the apparatus located in a screened place, which should be done for additional safety. The film of oil also prevents the breeding of mosquitoes in the barrel. Accordingly, so far as the privy as a breeding or feeding place of flies and mosquitoes is concerned, the model in question completely solves the problem.

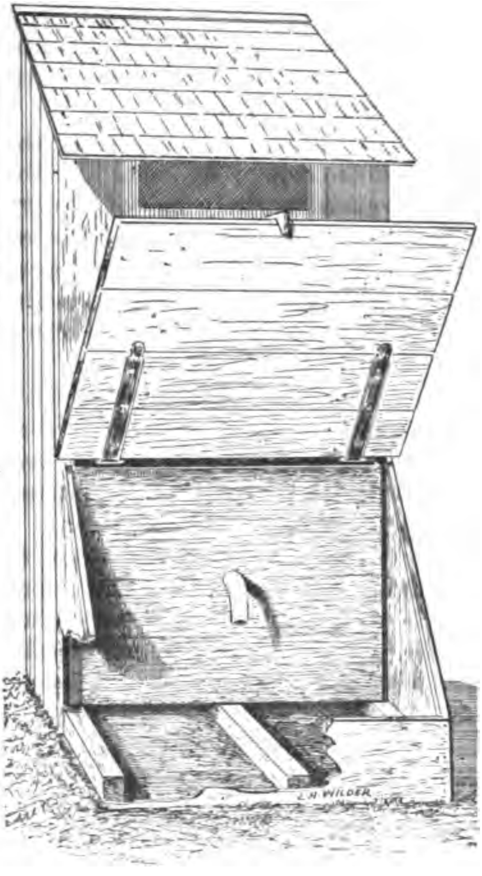

FIG. 5.—Rear view of L. R. S. privy.

The fecal material becomes fermented in the water and gradually liquefies; as the excreta settle, the level of the liquid is raised and the excess flows into the effluent tank, where it is protected from insects by the cover and by a film of oil. This effluent may be allowed to collect in the tank until it reaches the level of the connecting pipe, when it may be safely disposed of in various ways to be discussed later.

It is thus seen that this device appears to meet the following requirements:

(1) It solves the fly problem and the mosquito problem, so far as the privy is concerned.

(2) It liquefies fecal material and reduces its volume, so that it may be safely disposed of more easily and cheaply than the night soil from other types of privies.

(3) It reduces odor.

(4) It reduces the labor of cleaning the privy and makes this work less disagreeable.

(5) It is of simple and inexpensive construction.

This device has been in constant operation in one of the workrooms on the main floor of the Hygienic Laboratory at Washington for 8 months and has been found entirely satisfactory. From July 12, 1910, to April 1, 1911, namely, 262 days, it has been used 738 times, giving an average of 2⅘ defecations (with urination) per day. The amount of overflow (effluent) from the liquefying tank has been 59 gallons. The liquefying tank itself consists of an ordinary water-tight 40-gallon whisky barrel, and it has not been necessary thus far either to add water or to empty it.

Tests of this device are now being made in out-of-doors privies in order to determine the effect upon it of varying conditions of temperature and humidity. Tests are also being made to bring out whatever objectionable features may arise in connection with its general use and to determine the simplest methods of managing the device so that any family will have no difficulty in keeping it in proper working order.

The handle of the antisplasher should come up through the seat board at the side of the hole. By this arrangement the antisplasher can be raised entirely out of the water and thus used to sink the toilet paper and fecal matter if too much floats on the surface.

As an effluent tank, various receptacles can be utilized. If an iron pot is used, place on stones or provide with legs so that a space is left under it to permit the building of a fire as the effluent can be easily and cheaply disinfected by heat.

As a liquefying tank one may use either a barrel or an iron tank, or a box, or a brick vault, or a concrete vault. Whatever is used for this purpose must be strictly water-tight. Iron or concrete will cost more than wood, but on account of greater durability will be more economical in the long run.

The larger the family the larger the liquefying tank must be. A 40-gallon barrel, such as a whisky or oil barrel, seems sufficient for a family of 3 adults. For a larger family, the capacity should be increased by using two or more barrels or one larger receptacle, in the proportion of about 40 gallons capacity to every 3 to 4 adults in the family.

One advantage the device possesses is that with very little expense it can be put in the outhouses already in use; in fact, it can be placed in any of the outhouses on the farm, such as barn or woodshed, and thus save the expense of building for this special purpose. Wherever put, it is very important to have it in a place screened against flies.

From the out-of-door experiments thus far it can be readily foreseen that two factors come into consideration which have not been found important in the indoor privy, namely, evaporation and changes of temperature.

In cold weather the fermentation is not so rapid as in warm weather, and on this account the contents of the liquefying tank may gradually thicken.

The evaporation out of doors will vary greatly with the wind, humidity, and temperature in different regions, and the greater the evaporation the thicker the material in the liquefying tank becomes.

Should such thickening occur, the odor will increase, and it will be necessary to add water to the liquefying tank. In order to prevent such thickening, it may be found necessary in some instances to add water from time to time. Just how often and how much water should be added, under adverse conditions, has not yet been determined, but, so far as can be foreseen at present, probably a bucketfull (about 2 gallons) added once a week will be sufficient for a single barrel used by a family of 3 or 4 adults.

Experiments have conclusively demonstrated that the principle of the L. R. S. privy is good. The details regarding the addition of water must be determined experimentally in different localities. Any intelligent farmer should be able to determine this point for his own locality.[1]

If this type of privy is managed fairly intelligently, the indications are that the liquefying tank will rarely need cleaning, probably not oftener than once in several years. When cleaning does become necessary, this can be done in several ways: The barrel may be taken out, and its contents burned; or the contents may be pumped or dipped out, and burned; or a considerable amount (several barrelfuls) of water can be poured gradually into the liquefying tank, and the sludge thoroughly stirred until it runs over into the effluent tank.

In the experimental L. R. S. privy the only paper used has been the regular toilet paper. This has liquefied with sufficient promptness. If heavier paper (such as newspaper) were used, this would break up more slowly, and allowance for it might have to be made by increasing the capacity of the tank. It is well to bear in mind that the ink on newspaper is likely to irritate the skin. Corncobs and similar objects would certainly interfere materially with the successful working of any apparatus of this kind.

DIRECTIONS FOR BUILDING A SANITARY PRIVY.

There are many different ways that a privy building can be constructed. The details of construction are here appended for only one of the many different styles.

In order to put the construction of a sanitary privy for the home within the carpentering abilities of boys, a practical carpenter has been requested to construct models to conform to the general ideas expressed in this article and to furnish estimates of the amount of

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[1] It should be understood that the L. R. S. privy is described simply as a type, and may be modified to suit varying conditions.

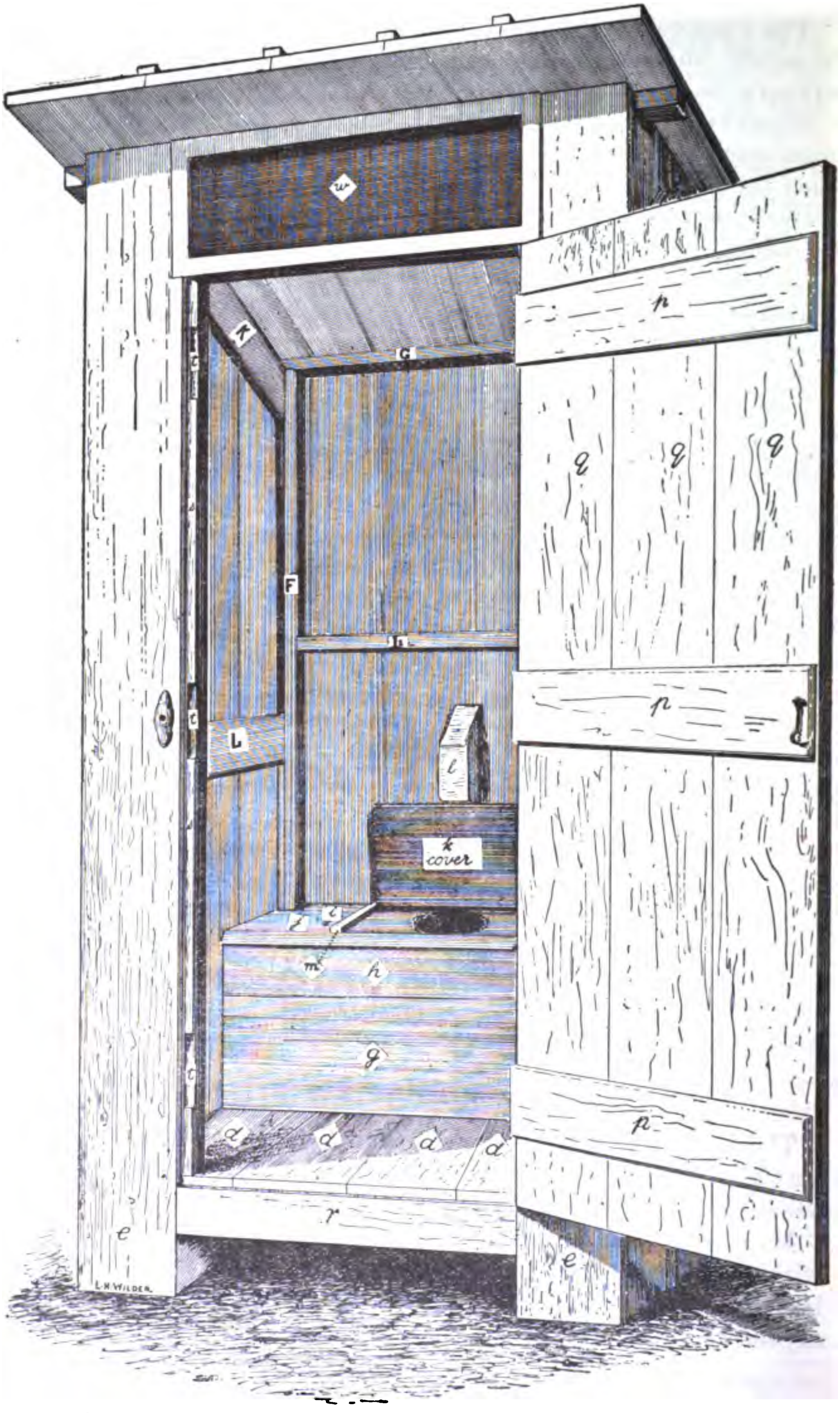

FIG. 6.—A single-seated sanitary privy. Front view. (Stiles, 1910.)

lumber, hardware, and wire screening required. Drawings of these models have been made during the process of construction (figs. 8, 9) and in completed condition (figs. 6, 7). The carpenter was requested to hold constantly in mind two points, namely, (1) economy and (2) simplicity of construction. It is believed that any 14-year-old school boy of average intelligence and mechanical ingenuity can, by following these plans, build a sanitary privy for his home at an expense for building materials, exclusive of receptacle, of $5 to $10, according to locality. It is further believed that the plans submitted cover the essential points to be considered. They

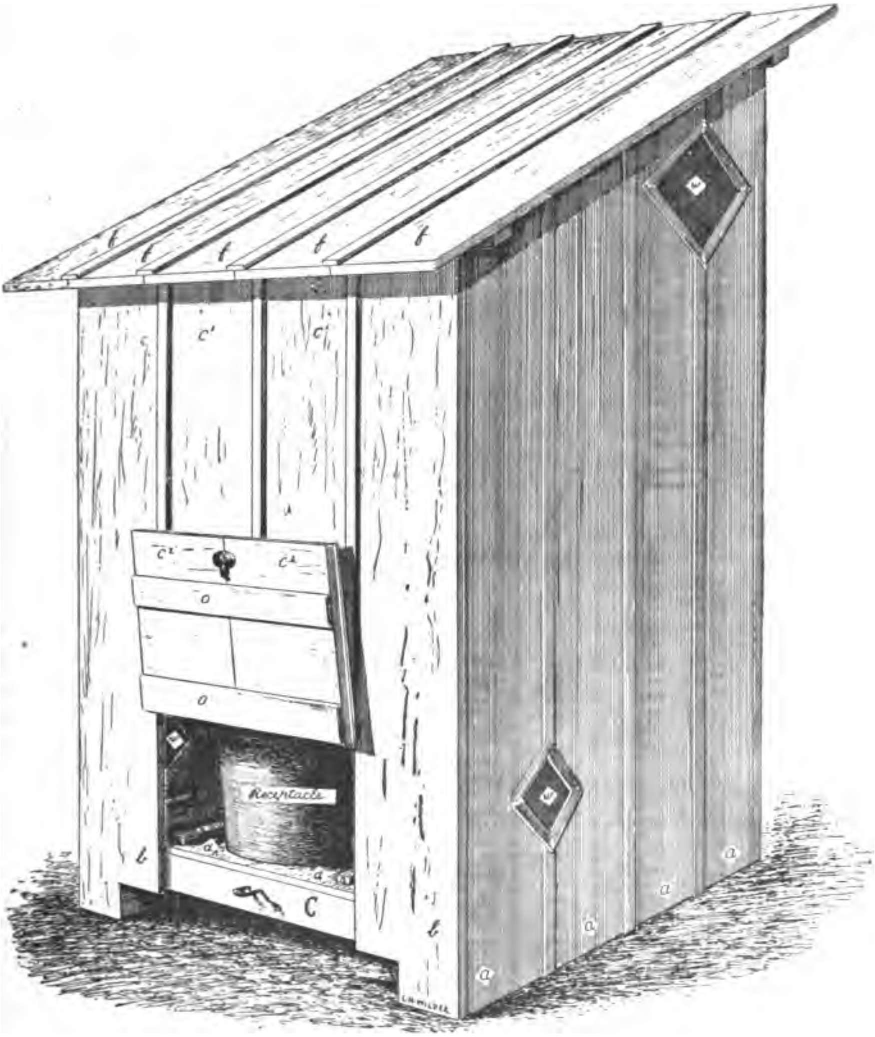

FIG. 7.—Rear and side view of a single-seated sanitary privy.

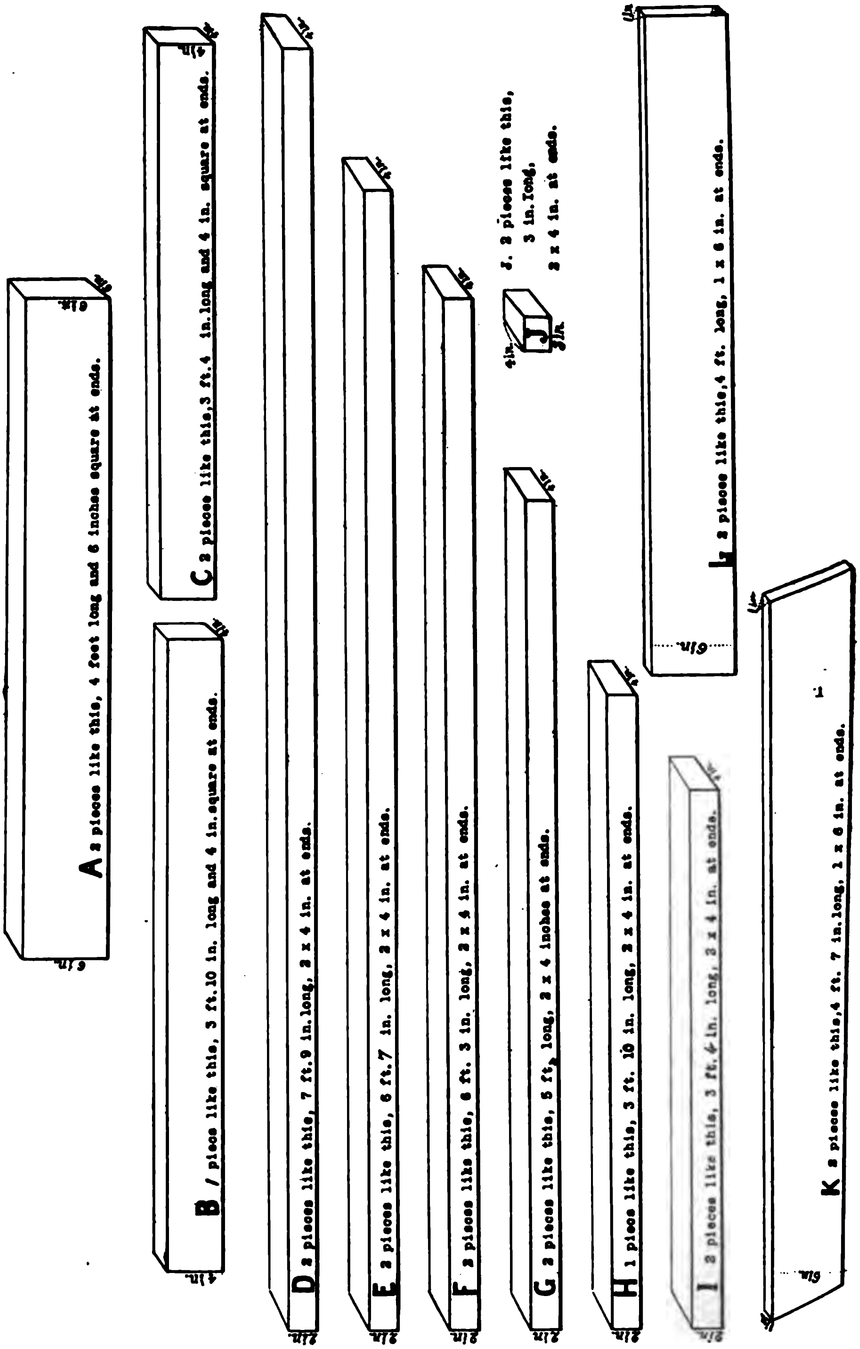
A 2 pieces like this, 4 feet long and 6 inches square at ends.
6in.
6in.
B 1 piece like this, 3 ft. 10 in. long and 4 in. square at ends.
4in.
C 2 pieces like this, 3 ft. 4 in. long and 4 in. square at ends.
4in.
D 2 pieces like this, 7 ft. 9 in. long, 2 x 4 in. at ends.
E 2 pieces like this, 6 ft. 7 in. long, 2 x 4 in. at ends.
F 2 pieces like this, 6 ft. 3 in. long, 2 x 4 in. at ends.
G 2 pieces like this, 5 ft. long, 2 x 4 inches at ends.
H 1 piece like this, 3 ft. 10 in. long, 2 x 4 in. at ends.
I 2 pieces like this, 3 ft. 4 in. long, 2 x 4 in. at ends.
J. 2 pieces like this, 3 in. long, 2 x 4 in. at ends.
J
4in.
2in.
L 2 pieces like this, 4 ft. long, 1 x 6 in. at ends.
6in.
1in.
K 2 pieces like this, 4 ft. 7 in. long, 1 x 6 in. at ends.
6in.
1in.
2in.
4in.

FIG. 8.—The scantling necessary for the framework of a single-seated sanitary privy, fig. 6. (Stiles, 1910.)

can be elaborated to suit the individual tastes of persons who prefer a more elegant and more expensive structure. For instance, the roof can have a double instead of a single slant, and can be shingled; the sides, front, and back can be clapboarded, or they can be shingled. Instead of one seat (figs. 6, 7), there may be two, three, four, five, or six seats, according to need.

A SINGLE-SEATED PRIVY.

Nearly all privies for the home have seats for two persons, but a single-seated privy can be made more economically.

Framework.—The lumber required for the framework of the outhouse shown in figure 6 is as follows (see figs. 8, 9):

A, two pieces, 6 by 6 inches, 4 feet long.
B, one piece, 4 by 4 inches, 3 feet 10 inches long.
C, two pieces, 4 by 4 inches, 3 feet 4 inches long.
D, two pieces, 2 by 4 inches, 7 feet 9 inches long.
E, two pieces, 2 by 4 inches, 6 feet 7 inches long.
F, two pieces, 2 by 4 inches, 6 feet 3 inches long.
G, two pieces, 2 by 4 inches, 5 feet long.
H, one piece, 2 by 4 inches, 3 feet 10 inches long.
I, two pieces, 2 by 4 inches, 3 feet 4 inches long.
J, two pieces, 2 by 4 inches, 3 inches long.
K, two pieces, 1 by 6 inches, 4 feet 7 inches long. The ends of K should be trimmed after being nailed in place.
L, two pieces, 1 by 6 inches, 4 feet long.

First lay down the sills marked A, and join them with the joist marked B; then nail in position the two joists marked C, with their ends 3 inches from the outer edge of A; raise the corner posts (D and F), spiking them at bottom to A and C, and joining them with L, I_2, G, and K; raise doorposts E, fastening them at J, and then spike I_1 in position; H is fastened to K.

Sides.—Each side (fig. 7) requires four boards (*a*) 12 inches wide by 1 inch thick and 8 feet 6 inches long; these are nailed to K, L, and A. The corner boards must be notched at G, allowing them to pass to bottom of roof; next draw a slant from front to back at G–G on the outside of the boards, and saw the four side boards to correspond with this slant.

Back.—The back (fig. 7) requires two boards (*b*) 12 inches wide by 1 inch thick and 6 feet 11 inches long, and two boards (*c*) 12 inches wide by 1 inch thick and 6 feet 5 inches long. The two longest boards (*b*) are nailed next to the sides; the shorter boards (*c*) are sawed in two, so that one piece (c^1) measures 4 feet 6 inches, the other (c^2) 1 foot 11 inches; the longer portion (c^1) is nailed in position above the seat; the shorter portion (c^2) is later utilized in making the back trapdoor.

Floor.—The floor (fig. 6) requires four boards (*d*) which (when cut to fit) measure 1 inch thick, 12 inches wide, and 3 feet 10 inches long.

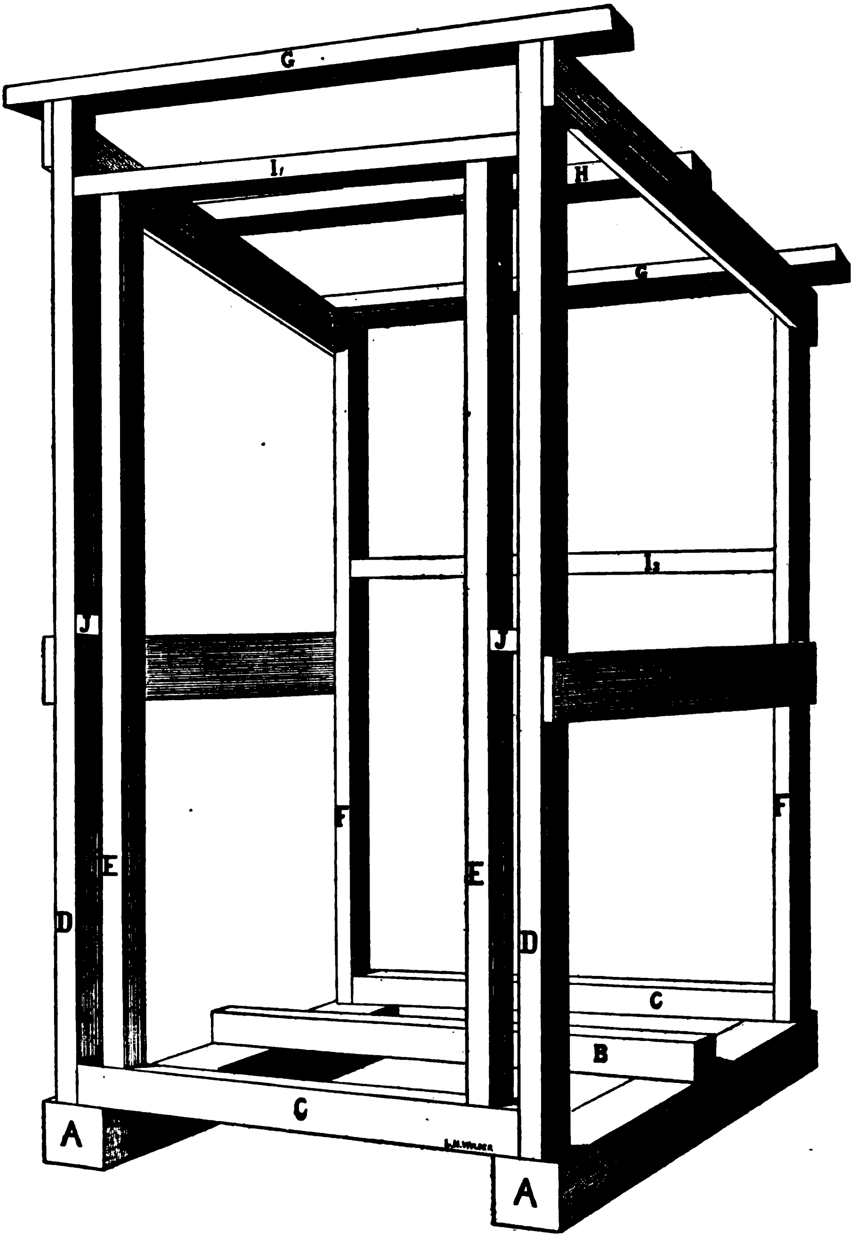

FIG. 9.—The framework (assembled) for a single-seated sanitary privy. (Stiles, 1910.)

Front.—The front boards may next be nailed on. The front (fig. 6) requires (besides the door) two boards (*e*), which (when cut to fit) measure 1 inch thick, 9 inches wide, and 8 feet 5 inches long; these are nailed next to the sides.

Roof.—The roof (fig. 7) may now be finished. This requires five boards (*f*) measuring (when cut to fit) 1 inch thick, 12 inches wide, and 6 feet long. They are so placed that they extend 8 inches beyond the front. The joints (cracks) are to be broken (covered) by laths ½ inch thick, 3 inches broad, and 6 feet long.

Box.—The front of the box (fig. 6) requires two boards, 1 inch thick and 3 feet 10 inches long. One of these (*g*) may measure 12 inches wide, and the other (*h*) 5 inches wide. These are nailed in place, so that the back of the boards is 18 inches from the inside of the back boards. The seat of the box requires two boards, 1 inch thick, 3 feet 10 inches long; one of these (*i*) may measure 12 inches wide, the other (*j*) 7 inches wide. One must be jogged (cut out) to fit around the back corner posts (F). An oblong hole, 10 inches long and 7½ inches wide, is cut in the seat. The edge should be smoothly rounded or beveled. An extra (removable) seat for children may be made by cutting a board 1 inch thick, 15 inches wide, and 20 inches long; in this seat a hole is cut, measuring 7 inches long by 6 inches wide; the front margin of this hole should be about 3 inches from the front edge of the board. To prevent warping, a cross cleat is nailed on top near or at each end of the board.

A cover (*k*) to the seat should measure 1 inch thick by 15 inches wide by 20 inches long; it is cleated on top near the ends to prevent warping; it is hinged in back to a strip 1 inch thick, 3 inches wide, and 20 inches long, which is fastened to the seat. Cleats (*m*) may also be nailed on the seat at the sides of the cover. On the inside of the back board, 12 inches above the seat, there should be nailed a block (*l*), 2 inches thick, 6 inches long, extending forward 3¼ inches; this is intended to prevent the cover from falling backward and to make it fall down over the hole when the occupant arises.

On the floor of the box, underneath the seat (fig. 7), two or three cleats (*n*) are nailed in such a position that the tub will always be in the center; the position of these cleats depends upon the size of the tub.

Back trapdoor.—In making the back of the privy (fig. 7), the two center boards (*c*) were sawed at the height of the bottom of the seat. The small portions (c^2) sawed off (23 inches long) are cleated (*o*) together so as to form a back trapdoor which is hinged above; a bolt or a button is arranged to keep the door closed.

Front door.—The front door (fig. 6) is made by cleating (*p*) together three boards (*q*) 1 inch thick, 10 inches wide, and (when finished) 6 feet 7 inches long; it is best to use three cross cleats (*p*) (1 inch thick, 6 inches wide, 30 inches long), which are placed on the inside. The door is hung with two hinges (6-inch "strap" hinges will do), which are placed on the right as one faces the privy, so that the door opens from the left. The door should close with a coil spring (cost about 10 cents) or with a rope and weight, and may fasten on the inside with a catch or a cord. Under the door a cross-piece (*r*) 1 inch thick, 4 inches wide, 30 inches long (when finished) may be nailed to the joist. Stops (*s*) may be placed inside the door as shown in figure 6. These should be 1 inch thick, 3 inches wide, and 6 feet 6 inches long, and should be jogged (cut out) (*t*) to fit the cross cleats (*p*) on the door. Close over the top of the door place a strip 1 inch thick, 2 inches wide, 30 inches long, nailed to I (fig. 9). A corresponding piece (*v*) is placed higher up directly under the roof, nailed to G. A strap or door pull is fastened to the outside of the door.

Ventilators.—There should be 5 ventilators (*w*). One is placed at each side of the box, directly under the seat; it measures 6 to 8 inches square. Another (12 inches square) is placed near the top on each side of the privy. A fifth (30 inches long, 8½ inches wide) is placed over the door, between G and I_1 (figs. 6, 9). The ventilators are made of 15-mesh copper wire, which is first tacked in place and then protected at the edge with the same kind of lath that is used on the cracks and joints.

If the L. R. S. system (p. 17) is used and the barrel or tank brought close to the seat, the ventilators at the sides of the box may be done away with, and the barrel may be ventilated by a pipe (such as a joint of stove pipe), extending through the seat to the roof or through the back of the house; this ventilator should be screened.

Lath.—Outside cracks (joints) are covered with lath ½ inch thick by 3 inches wide.

Receptacle.—For a receptacle, saw a water-tight barrel to fit snugly under the seat; or purchase a can or tub, as deep (17 inches) as the distance from the under surface of the seat to the floor. If it is not possible to obtain a tub, barrel, or can of the desired size, the receptacle used should be elevated from the floor by blocks or boards so that it fits snugly under the seat. A galvanized can measuring 16 inches deep and 16 inches in diameter can be purchased for about $1, or even less. An empty candy bucket of about the same size can be purchased for about 10 cents.

This same outhouse may be used for the L. R. S. privy (p. 17), in which case it is not necessary to extend the floor under the seat; instead of doing this, a hole is dug deep enough to receive the barrel or vault; or if preferred, the house can be elevated high enough to make room for the barrel (see fig. 3).

Order for material.—The carpenter has made out the following order for lumber (pine, No. 1 grade) and hardware to be used in building a privy such as is shown in figure 6:

1 piece, 6 by 6 inches by 8 feet long, 24 square feet.
1 piece, 4 by 4 inches by 12 feet long, 16 square feet.
5 pieces, 2 by 4 inches by 16 feet long, 54 square feet.
3 pieces, 1 by 6 inches by 16 feet long, 24 square feet.
2 pieces, 1 by 9 inches by 9 feet long, 14 square feet.
3 pieces, 1 by 10 inches by 7 feet long, 18 square feet.
15 pieces, 1 by 12 inches by 12 feet long, 180 square feet.
12 pieces, ½ by 3 inches by 16 feet long, 48 square feet.
2 pounds of 20-penny spikes.
6 pounds of 10-penny nails.
2 pounds of 6-penny nails.
7 feet screen, 15-mesh, copper, 12 inches wide.
4 hinges, 6-inch "strap," for front and back doors.
2 hinges, 6-inch T, or 3-inch "butts," for cover.
1 coil spring for front door.

According to the carpenter's estimate these materials will cost from $5 to $10, according to locality.

There is some variation in the size of lumber, as the pieces are not absolutely uniform. The sizes given in the lumber order represent the standard sizes which should be ordered, but the purchaser need not expect to find that the pieces delivered correspond with mathematical exactness to the sizes called for. On this account the pieces must be measured and cut to measure as they are put together.

ESTIMATE OF MATERIAL FOR SCHOOL OR CHURCH PRIVY.

The following estimate of building materials has been made, by a carpenter, for the construction of a six-seated school or church privy. The estimated cost of these materials is $25 to $50, according to locality; this does not include the pails or barrels:

3 pieces, 6 by 6 inches by 20 feet, 180 square feet.
1 piece, 6 by 6 inches by 8 feet, 24 square feet.
Scantling, 2 by 4 inches, 165 square feet.
Boards, 1 by 12 inches, 600 square feet.
Boards, 1 by 10 inches, 185 square feet.
Boards, 1 by 8 inches, 100 square feet.
Boards, 1 by 6 inches, 80 square feet.
Boards, ½ by 3 inches, 100 square feet.
Flooring, 80 square feet.
40 feet 15-mesh copper wire screen, 12 inches wide.
12 pairs of hinges, 6-inch "strap."
6 pairs of hinges, 6-inch T.
3 pounds of 20-penny spikes.
15 pounds of 10-penny nails.
8 pounds of 6-penny nails.
6 coil springs for front doors.
6 knobs or latches.

HOW TO KEEP A PRIVY SANITARY.

It is necessary not only to build a privy properly but also to keep it in proper condition. This involves cleaning out and disposing of the excreta in such a way as to prevent all possibility of the spread of disease germs from the material. The disagreeable labor involved varies according to the kind of privy in use, but is less with the L. R. S. privy than with the other types.

Wrong ways of disposing of night soil.—(1) The point can not be emphasized too strongly that the use of fresh night soil as fertilizer endangers the health and life not only of every person on the farm itself, but of all people who handle or who consume the fresh vegetables and fresh milk from such a farm. The custom is forbidden by law in some States.

(2) If the fresh night soil is simply buried, germs of disease may later be brought to the surface, and thus infection may be spread. Further, the popular idea that all the fly grubs in the night soil are killed by burial is not correct, for these grubs can crawl up through as much as 6 feet of sand, reach the surface, develop into flies, and carry filth and disease germs to the food. Further, also, if the fresh night soil is buried, it may infect the water supply (springs, wells, etc.), and thus spread disease. Widespread as is the custom of burying fresh excreta, it is a custom which in the light of present-day knowledge must be viewed as being far from safe, although when done with great care it does decrease the dangers to some extent.

(3) Mixing night soil with manure is especially dangerous, and feeding it to chickens and hogs is both filthy and dangerous.

(4) To leave the night soil on the ground near the privy is deliberately to expose the family and neighbors to sickness.

(5) In some instances farmers collect the fresh night soil from towns and villages, and haul it to their farms, under the impression that if it is promptly plowed under it will enrich the land and no harm can result. Farmers should thoroughly understand that the following of such a practice is attended with great danger, as typhoid fever, hookworm disease, and other infections may thereby be introduced from the town to a healthful farm.

(6) In some instances, the privy is built over a creek, or the fresh excreta are thrown into a stream or lake. Such practices may endanger the lives of persons living downstream.

The right way to dispose of night soil.—Since it is not known, at any given time, which members of a community harbor disease germs in their intestines, the invariable rule should be adopted to consider all fresh night soil as a virulent poison and to dispose of it accordingly.

The only safe way of disposing of fresh night soil from the style of privy shown in figures 6 and 7 is to burn it or disinfect it by means of heat. Any other method, such as burial or any practicable treatment with chemical disinfectants (lime, etc.), although lessening the danger to some extent, still carries with it risks involving human life.

If the wet method (p. 16) be used in the style of privy shown in figures 6 and 7, the excreta had best be heated to 212° F., after which the material may safely be used as fertilizer. A second method is to permit the filth to ferment in water in covered tubs or barrels for not less than a week after removal from the privy; then pour in a disinfectant (such as chloride of lime, one-fourth pound to the gallon of excreta); the material should then be buried. This second method greatly reduces but does not entirely remove the danger of the spread of disease.

Effluent (overflow) from the L. R. S. privy.—From what has been said above, it is clear that the proper disposal of night soil always involves some labor and trouble, but it is important constantly to hold in mind the truth that the results obtained, in better health, smaller doctors' bills, and the saving of human life, more than justify the efforts expended.

The L. R. S. privy reduces the volume of the excreta and converts the material into an easily manageable fluid, so that the disposal of night soil from this type of privy is much simplified. The methods of disposal which come into consideration are the following:

(1) Heat: If a suitable (metallic) vessel is provided to receive the effluent, a fire may be built under the vessel and the effluent heated to 212° F. Or if a wooden or concrete effluent tank is used, the effluent may be transferred to some other vessel for heating.

After such treatment the fluid may be safely used for fertilizer under any conditions.

Heat disinfection is the only measure which can to-day be recommended unreservedly.

(2) Burial: Burial will unquestionably decrease the danger of spreading infection, but in the present state of knowledge this method of disposal can not be relied upon as safe. If burial of the effluent is practiced, the fluid should be disposed of not less than 300 feet from and downhill from any neighboring water supply and not less than 2 feet underground, and then only provided the soil itself is a good filter. Burial in a limestone region may contaminate water supplies miles away.

(3) Chemical disinfection: Chemical disinfectants, such as chlorinated lime and certain coal-tar derivatives, have the great advantage of cheapness and can be relied upon to destroy the disease-causing bacteria in the night soil. The knowledge regarding the action of chemical disinfectants upon the eggs and spores of the various animal parasites is at present very rudimentary, but, so far as results are known, their practicable use does not seem to be so efficient in the

destruction of the animal parasites as of the bacteria. Therefore, pending further investigations, the use of chemically treated excrement as fertilizer should not be regarded as unqualifiedly safe.

(4) Chemical disinfection, with subsequent burial: Inasmuch as chemical disinfection can be relied upon to destroy the disease-producing bacteria in night soil, and inasmuch as burial greatly reduces the danger from animal parasites, a suitable combination of the two methods (chemical disinfection and burial) can be used with reasonable safety.

(5) Sewers: In partially sewered towns the effluent from these privies may be emptied into the sewers. If conditions are such that the addition of this material to the sewage is dangerous, then the entire sewer system needs correction.

THE PRIVY AT THE COUNTRY SCHOOL AND CHURCH.

Although a farmer may prevent soil pollution on his own farm by the use of sanitary privies, his children may be exposed to the dangers of soil pollution at the schools which they attend, and his entire family may be so exposed even when they attend church, unless the schools and churches are provided with sanitary privies. In fact, schools and churches not provided with such outhouses necessarily form distributing centers from which certain diseases spread to clean farms.

CIVIC RESPONSIBILITY IN RESPECT TO PRIVIES.

Lack of sanitary privies on neighboring farms may be responsible for cases of typhoid fever, hookworm disease, and other infections on farms which are provided with sanitary privies, because disease germs may be carried for considerable distances by flies, by animals, by feet of persons, by wagon wheels, or by drainage from one farm to another.

In view of these well-established facts it is evident that among the highest duties that rest upon a farmer, as a father and citizen, is not only to have a sanitary privy on his farm, but to insist that the pollution of soil with human excreta be prevented throughout the entire neighborhood by the use of sanitary privies.

In the United States about 400,000 persons suffer from and about 35,000 die from typhoid each year; over 2,000,000 persons have hookworm disease. Thousands of these deaths and many thousands of these cases of disease might be prevented by the simple use of sanitary privies. A compulsory sanitary privy law or ordinance should therefore be enacted and be strictly enforced in every locality not provided with a properly maintained sewer system.

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Issued August 31, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 464.

THE ERADICATION OF QUACK-GRASS.

BY

J. S. CATES,
Assistant Agriculturist, Office of Farm Management,
Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., June 14, 1911.

Sir: I have the honor to transmit herewith a manuscript entitled "The Eradication of Quack-Grass," by Mr. J. S. Cates, Assistant Agriculturist, Office of Farm Management, and recommend that it be published as a Farmers' Bulletin.

Respectfully,
B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—687.

THE ERADICATION OF QUACK-GRASS.

INTRODUCTION.

While the studies outlined in this bulletin have been made on ordinary quack-grass or witch-grass (*Agropyron repens*), prevalent in the North-Central and Northeastern States, other observations not presented in this paper lead us to believe that the same principles here laid down apply equally well to all rootstock-producing species of this same genus, embracing a large number of closely allied grasses found in the Rocky Mountains and the Pacific States.

THE UNDERGROUND STEMS OF QUACK-GRASS.

The underground stems are the seat of the remarkable vitality of quack-grass; therefore, for a full understanding of this subject the plant in its relations to the underground stems will first be briefly considered. These stems are often called roots. They are not roots in the true sense of the word, but rootstocks, that is, underground stems. The distinction between rootstocks and roots is that rootstocks have buds on them as stems do, while roots do not. Another very important distinction is that rootstocks do not absorb material from the ground, while roots do. The rootstocks are dependent for their growth upon the material absorbed by the roots and elaborated in the leaves in combination with the material which the leaves draw from the air. This material elaborated in the leaves then goes down to form the underground stems, or rootstocks. The plant is simply storing up material to draw on next year.

As the material for the growth of rootstocks comes from the leaves, the amount of leaf growth which the plant produces in any one season is largely a measure of the amount of rootstock growth. So, by limiting the development of top in any way the number of underground stems produced is thereby limited. If little or no top is allowed to grow very little rootstock will be developed. Just as we would expect a small crop of potatoes if we were to keep the top of the potato plant cut back close to the earth, so should we expect a minimum of rootstock growth to be produced by the quack-grass plant if its top is kept closely cut. By actual observations this is found to be true.

There are three types of management of quack-grass land that bring about three widely different conditions in the vitality of the plant. The three resulting types of quack-grass land are given below.

TYPES OF QUACK-GRASS LAND.

(1) **A cultivated field infested with quack-grass.** (Fig. 1.)—The deepest and most vigorous rootstock development of quack-grass is found in cultivated fields. There are several factors which cause this. The principal one is probably deep preparation of the land.

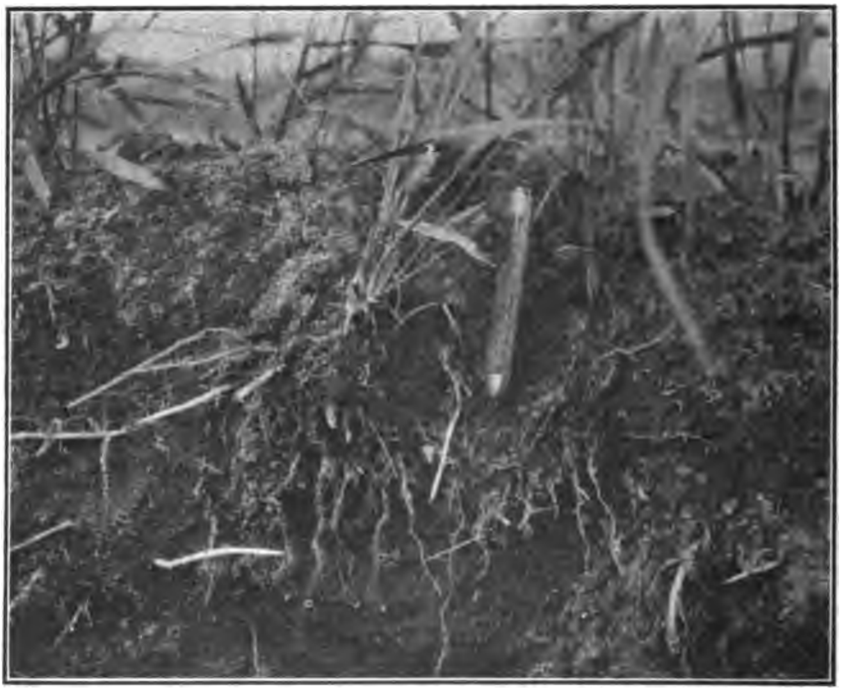

FIG. 1.—Cross section of cultivated land, showing quack-grass rootstocks scattered through the soil to a depth of 7 inches.

When the plant is left undisturbed the rootstocks have a tendency to get nearer the surface every year. (Figs. 2 and 3.) Deep plowing puts the stem back to the bottom of the furrow, and a mass of tangled growth is then sent out toward the surface, a large part of the vitality of the buried stems going into new stems reaching toward the surface. This new growth lives until the next year. When the stems are buried deeply to begin with and cultivation is not kept up long enough to kill out the grass (and it usually is not on this type of land), the plant takes on a new lease of life after cultivation stops, the loose deep soil furnishing an ideal place in which to grow. As a consequence, the plant becomes firmly established and is well able to stand the next year's battle.

(2) **Meadowlands.** (Fig. 2.)—If the meadow has been down for several years, and especially if two cuttings of hay a year have been secured, the rootstock development is found to be about half the extent and depth of that found in cultivated land.

(3) **Pasture lands.** (Fig. 3.)—The smallest rootstock development is found in closely grazed pasture lands. Here the underground growth of quack-grass finally becomes a few mere shreds of rootstocks, and these are very near the surface.

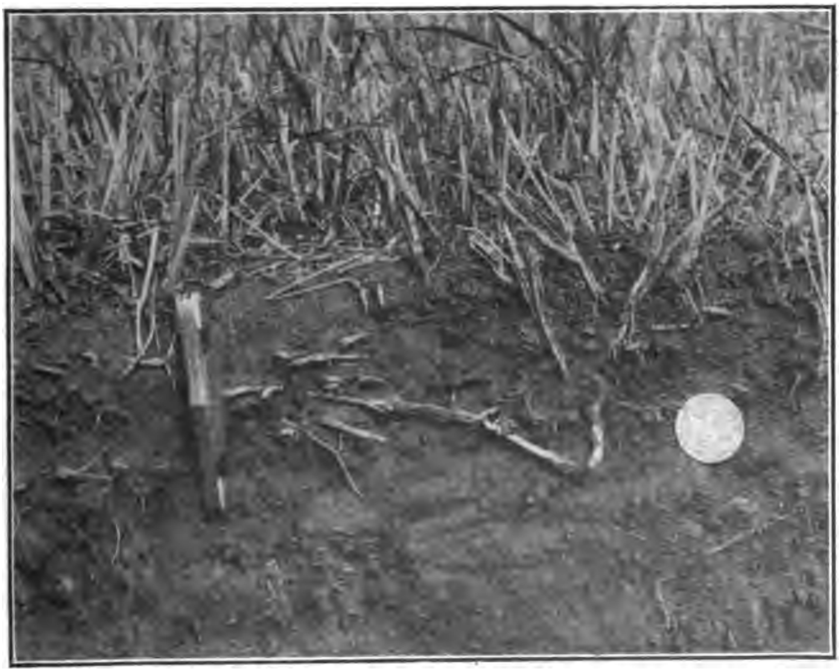

FIG. 2.—Cross section of quack-grass meadowland, showing rootstocks confined to the first 3 inches below the surface.

After completing the studies, as heretofore outlined, of the rootstock habits of quack-grass under different field conditions, experimental work was undertaken looking to the discovery of a practical method for the control of this pest. That quack-grass can be destroyed by persistent clean cultivation is well recognized; that the grass in its worst form (where infesting a cultivated field) can be killed in one season and a crop produced simultaneously has been demonstrated.[1] The chances of a farmer, however enthusiastic he may be at the beginning of such an undertaking, carrying work of this kind through to a successful conclusion are very problematical. Such work requires considerable labor of a more or less careful, painstaking nature at a very busy season of the year. The early growing season is a period of many interests, and generally as soon as the farmer finds that the quack-grass is fairly well under control he immediately centers his interest on some other seemingly more important line of farm work. The result is that the pest soon gets another good start, and the crop by this time has advanced so far toward maturity that strenuous cultivation would be detrimental to the yield. Consequently, the remainder of the work is taken out in good intentions for the next year.

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[1] See Bulletin 149, Vermont Agricultural Experiment Station.

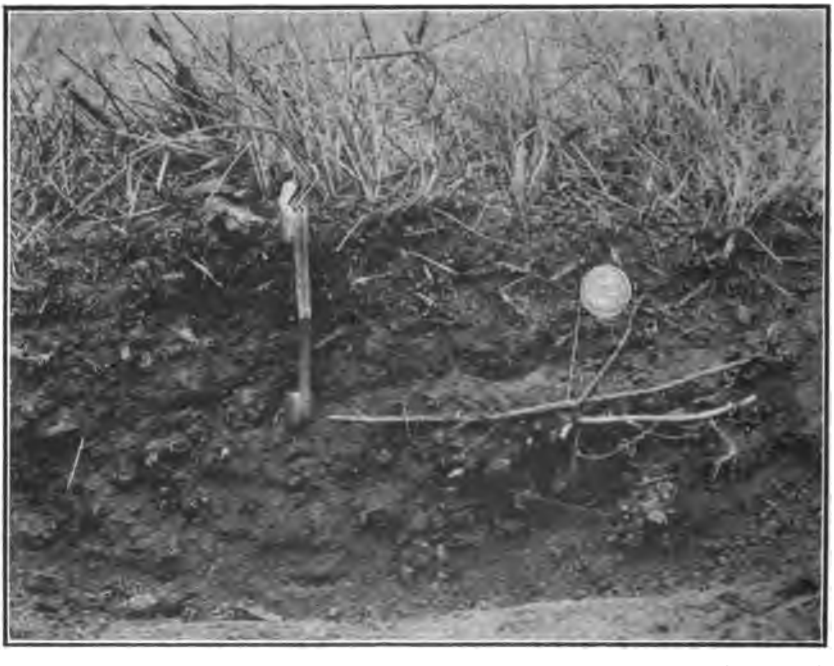

FIG. 3.—Cross section of old pasture sod, showing quack-grass rootstocks confined mainly to the first 2 inches below the surface.

MIDSUMMER THE BEST SEASON TO BEGIN ERADICATION.

Bearing these facts in mind our investigations have naturally centered on methods that could be used during the periods when other farm work is not very pressing. In midsummer, immediately after haying, there is usually a period of more or less relaxation from general farm work. This is a season of the year also when rootstock grasses seem to be at their lowest state of vitality. The hay crop too has been secured from the sod land and nothing more is to be produced the current season on these lands; therefore, no crop is lost. If the work is begun on pasture lands, at least a half season of pasturage has been obtained. It is only on sod and pasture lands that it seems to be advisable to attempt to destroy quack-grass by the method here outlined, as was pointed out in the discussion of the root-stock habits of the grass under varying field conditions.

HOW TO KILL QUACK-GRASS.

The process of killing quack-grass on sod or pasture lands, beginning in midsummer, is a very simple one.

The first step is to plow the sod, cutting just under the turf, which is usually about 3 inches deep. To thoroughly turn over a stiff quack-grass sod as shallow as 3 inches it is advisable to use a special type of plow (Scotch bottom) having a very long, gradually sloping moldboard. (Fig. 4.) It has been found that with this type of plow the sod can be turned very shallow. The next step is to go in a week or ten days later with a disk harrow and thoroughly disk the sod. Repeat this treatment every ten days or two weeks until fall, when the quack-grass will be completely killed out.

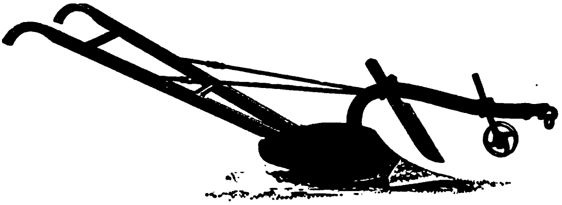

FIG. 4.—A Scotch-bottom plow used in turning quack-grass sod.

It sometimes happens that with certain kinds of soil during drier periods in the summer the ground becomes too hard to plow. With the type of plow suggested, however, it has been found that very hard and dry sods can be turned. In case it is not possible to turn the sod on account of dry weather, the treatment can be given with the disk harrow alone. We have been able to thoroughly kill the grass with either the disk or the combination of plow and disk treatment. Where plowing is possible, however, it is usually cheaper to kill the grass with plow and disk than with the disk alone. (Fig. 5.)

If the disk alone is to be used, it should be set practically straight, well weighted with bags of dirt, and the field gone over three or four times. The first two cuttings should be at right angles and the other cuttings diagonally across. The sod in this way is divided into small blocks. Then the disk is set at an angle, when it will be found that the first 2 or 3 inches of the sod, which contain practically all of the quack-grass roots, can be cut loose from the soil

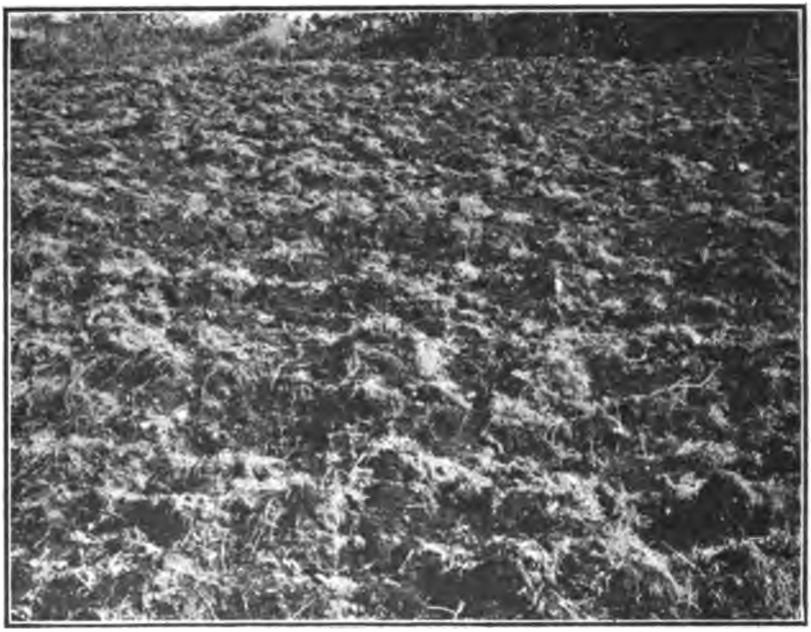

FIG. 5.—Meadowland sod as it appeared in the fall, after having been plowed shallow following haying in July and then disked at intervals of 10 days for the remainder of the summer.

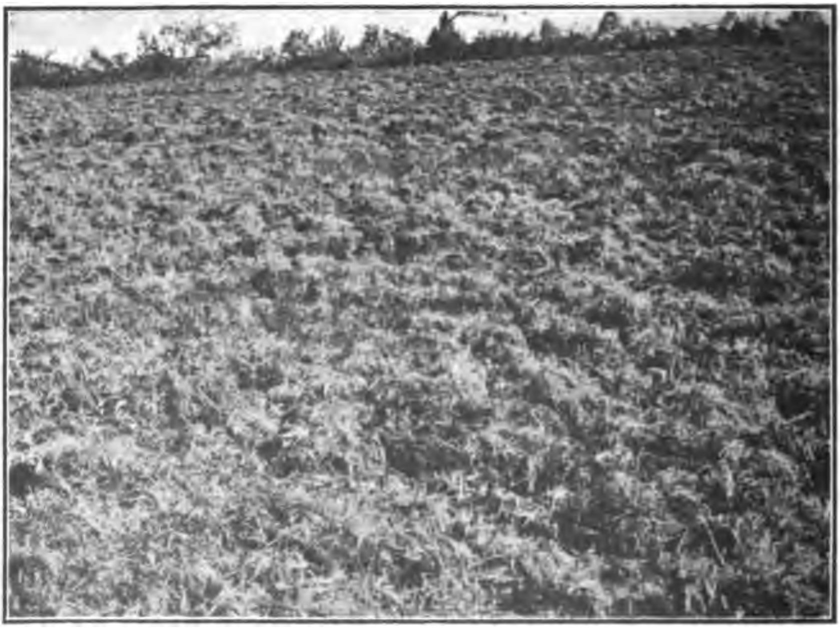

FIG. 6.—Meadowland sod as it appeared in the fall, after having been disked following haying in July.

below. The exposure to the sun and the breaking loose from the lower soil soon kill out the quack-grass. (Fig. 6.) This ground should be gone over at intervals of ten days or two weeks throughout the remainder of the season.

The following spring the infested land, on which the grass has been killed either by the disking method or by the combination of plowing and disking, should be plowed to a good depth in order to bury the mass of dead roots thoroughly. This will facilitate the cultivation of the spring crop. If the work has been carefully done the quack-grass will not show up at all in the spring crop.

Both these methods have been thoroughly tested on the farm of Mr. C. W. Locke, of Turner, Me. Figure 6 shows a view of disked land on this farm and figure 5 an area that has been both plowed and disked. The photographs from which these illustrations were made were taken in October, 1910. Quack-grass was thoroughly killed in both cases at that time.

A test of the method of plowing after haying, followed by disking until fall, has been made on the farm of Mr. Carl S. Kinney, Massena Center, St. Lawrence Co., N. Y. The sod, which has been down for several years, was plowed shallow in July and disked at intervals of ten days or two weeks until fall. The following spring it was cross-plowed, harrowed, and planted to corn. The corn received three cultivations but no hoeings. When examined in the midsummer following, not a sprig of quack-grass could be found.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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1384 Issued October 14, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 465.

Experiment Station Work,

LXV.

Compiled from the Publications of the Agricultural Experiment Stations.

COST OF AVAILABLE NITROGEN.
MANAGEMENT OF MARSH SOILS.
WEEDER HARROW FOR DRY FARMS.
V-SHAPED COTTON-STALK CUTTER.
STORAGE FOR ROOT CROPS.
DANGER IN FEEDING ROOT CROPS.
SANITARY CARE OF SWINE.
INDIVIDUALITY OF THE COW.
HATCHING AND REARING TURKEYS.

JULY, 1911.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

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[1] Director.

[2] Special agent in charge.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[1]

COST OF AVAILABLE NITROGEN.[2]

E. B. Voorhees shows in a bulletin of the New Jersey Experiment Stations that 40 per cent of the total amount annually expended for fertilizers in that State is paid for nitrogen, and this is probably typical for all regions where fertilizers are generally used. Moreover, nitrogen is the only one of the three essential elements of plant food likely to suffer any considerable loss in use, not more than 70 per cent of the nitrogen applied in the best forms being recovered in crops. There are no such losses of phosphoric acid and potash.

From the standpoint of crop it is evident that the utilization of nitrogen is a much more important matter than the use of phosphoric acid and potash, although the further fact that a pound of nitrogen, capable of being used in a commercial fertilizer, and without regard to form, costs from four to five times as much as a pound of "available" phosphoric acid or of potash, is an additional argument in favor of greater care in its purchase and use.

Nitrogen as nitrate is the only commercial form soluble in water, ready for immediate use by most plants. Nitrogen as ammonia is also a form soluble in water, but it is less available than the nitrate. A pound of nitrate and a pound of ammonia, being definite chemical compounds, are quite as good from one source as another.

Organic forms of nitrogen have to decay first, changing to ammonia and then to nitrate, and are therefore less quickly available; besides, they vary in their rate of availability according to the source of supply and their physical character. Materials which are likely to decay quickly, as dried blood, dried meat, dried fish, and cottonseed meal, do show a high rate of availability, while forms like ground leather and ground peat show a very low rate of availability. A pound of organic nitrogen varies in availability, therefore, according to its source, whether derived from dried blood or peat or from intermediate products.

Since nitrogenous materials are variable in their rate of availability—that is, the rate at which the nitrogen in them may be absorbed by the plant—the farmer desires to know the dependence that can be placed on the different materials. He wants available nitrogen. Hence, the chemical and physical characteristics of the various forms of nitrogen have been made the subject of very consider-

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[1] A progress record of experimental inquiries published without assumption of responsibility by the department for the correctness of the facts and conclusions reported by the stations.

[2] Compiled from New Jersey Stas. Buls. 221, 224; Rhode Island Sta. Buls. 142, 143.

able study and investigation, in order that at least approximate values in respect to availability may be attached to each form. Sufficient work has been done thus far to establish a pretty safe relationship between the nitrate, ammonia and organic nitrogen, in the form of dried blood.

The results of comparative experiments by the New Jersey Station show "that the recovery for nitrogen as nitrate was 62.09 parts per hundred; for the nitrogen as ammonia, 43.26 parts per hundred; and for organic (dried blood) nitrogen, 40 parts per hundred."

With the returns from nitrate, the highest recovery regarded as 100, the relative availability of the nitrogen as ammonia would be 69.7 and of nitrogen as dried blood 64.4.

These figures possess a very great practical significance, as they have a direct bearing upon the economical purchase and use of the nitrogen contained in the fertilizers now offered upon the market.

Commercial conditions fix the price of the various nitrogenous materials, and the cost to the farmer of any one form is not measured by its usefulness to him, but by the cost in the market. That is, there is no strict relationship between commercial and agricultural values.

It happens that at the present time a pound of nitrogen in the form of nitrate or of ammonia costs the farmer less than a pound of organic nitrogen; that is, the nitrogen possessing the highest rate of availability as nitrate is less expensive to him than dried-blood nitrogen, or even that derived from low-grade nitrogenous materials, which do not possess any definite rate and which must, on the average, show a much lower rate of availability than dried blood, because the mixtures contain nitrogen derived from many sources, not uniform in their content of nitrogen or in their physical character or constitution.

The experiment station has since its establishment consistently urged the farmers, in their purchase of fertilizers, to be guided not only by the quantities of the constituents present in the mixtures offered, but also by the kind that is used in them, pointing out the importance of selecting brands which contain high percentages of available plant food, more especially of nitrogen, because of its relatively greater importance or its higher cost.

The station does not discourage, but strongly encourages, the use of waste products containing nitrogen, but it insists that—

The cost to the farmer of a pound of nitrogen in these materials, of a value lower and more variable than the nitrate and ammonia, should be lower rather than higher than for nitrate or ammonia.

It is not economy to save refuse nitrogenous materials if the cost of the nitrogen to the farmer is greater and his returns less than may be obtained by the use of nitrogen from materials of known value. Farmers have been and are now spending thousands of dollars for nitrogen for which they do not receive a proportionate return.

To the farmer it is purely a business proposition. He buys nitrogen in order that he may get a return in crop. If in one case 100 pounds of nitrogen contributes 60 pounds to the crops upon which it is applied and in another 100 pounds contributes but 40 pounds to the crops, the purchaser should not pay the same for the second as for the first, for if he did so he would pay 50 per cent more per pound for his "available" nitrogen. That is, if the cost of the first hundred pounds were $15, the second hundred should cost but $10 when the basis of value is the amount available in each.

MANAGEMENT OF MARSH SOILS.[1]

The agricultural value of marsh or swamp lands has long been realized and it is generally recognized that their successful reclamation will add enormously to our national wealth as well as improve the sanitary conditions of the immediate and surrounding country.[2] In a bulletin of the Wisconsin Experiment Station A. R. Whitson and F. J. Sievers give valuable information on methods of draining, cultivating, and fertilizing such soils based upon observations and experiments in different parts of the State.

In draining extensive areas the construction of large main ditches requiring the use of a dredge will be necessary. In such cases coöperation among the adjoining owners is recommended either by organizing a drainage district or by having the town or county officer take charge of the work. With smaller areas this can usually be done by mutual agreement between two or three adjoining owners.

Two kinds of drainage must be provided for—first, surface drainage, and second, subsurface drainage. It is occasionally true that the construction of ditches around the edge of a marsh tract in such a way as to carry off most of the water from the surrounding higher land without letting it onto the marsh will reduce the wetness of the marshland to such an extent that crops can be grown without further ditching. Ordinarily, however, ditches on the marsh itself are necessary.

The necessity for subdrainage either by deep open ditches or tile depends very largely upon the character of the subsoil and its relation to the surrounding land. When subdrainage is necessary, the use of tile makes it possible to do away with open surface ditches and so greatly facilitates the operations of cultivation. Nevertheless, the muck and peat of marshlands usually shrinks and settles considerably on drainage, making it often desirable to leave open ditches for three or four years until this shrinking has taken place, after which the ditches may be cleaned out and tile laid and covered.

On some marshes, particularly those covering considerable areas where the marsh soil is coarse fibrous peat and underlaid at relatively shallow depths by coarse sand, it is possible that too thorough drainage may occur, so that crops on such land during very dry seasons may suffer for lack of water. Under such conditions it is quite probable that the use of dams at intervals in the mains and larger lateral ditches for holding back the water during very dry seasons will be found advantageous.

Where a deep growth of sphagnum moss occurs it is usually difficult or impossible to plow properly before this has been removed, and the only practical method for this purpose seems to be that of burning.

While it is ordinarily not considered desirable to burn soils more than is absolutely necessary, in such cases as this it can not be avoided, and there is much less objection to burning on marsh lands than on uplands, provided only so much of the surface is burned as is necessary to permit of good breaking. Indeed, the ash from this shallow surface burning adds greatly to the fertility of these lands for the first few years. Where the moss has considerable depth and on boggy marshes it can only be burned during a dry season and in the hot summer period of July and August. Great care must, of course, be used to prevent the spread of fire under such conditions.

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[1] Compiled from Wisconsin Sta. Bul. 205.

[2] See U. S. Dept. Agr. Farmers' Buls. No. 78, p. 7; No. 320, p. 9.

Whether burning is necessary or not, the summer and early fall is the best time for the plowing of such lands. Where the soil is of a mucky character a good stubble plow can ordinarily be used successfully. Where, however, the soil is peaty, a good breaking plow with very long mold board must be used, and the larger the plow the more successfully can the furrow slice be turned. For this reason the use of a large steam plow on such lands is very successful. Moreover, the great weight of such a plow is extremely beneficial to pack the soil so as to secure a firmer seed bed. This compacting of the peaty soil doubtless hastens its rotting and the necessary chemical decomposition to produce fertility, while it also firms the soil, thus greatly improving its texture as a seed bed, especially for cereals. These crops ordinarily do best on rather close soil, such as clay or clay loam, and the more nearly marsh soils can be brought into that condition the better will they be adapted to their culture. This, of course, must not be understood as meaning that marsh lands which are merely wet clay soils, even though they do contain considerable black and entirely decomposed organic matter in the form of humus, should be treated in this way. Such soils are often too compact and close and should be left in the rough furrow slice during the winter so as to allow the action of the frost after drainage to produce the granulation so necessary to a good tilth on such lands.

In chemical composition marsh soils were found to differ from upland soils chiefly in having a large amount of nitrogen and usually a relatively smaller amount of phosphorus and potash. In limestone regions the lime from subsoil and rock is dissolved out by the waters percolating through the soil so that these marshes are not acid.

In soils like these where there is at most a deficiency of one or two elements only and almost an oversupply of nitrogen, it would not seem wise to use a complete fertilizer containing large quantities of the three essential plant-food elements. Barnyard manure, which contains a liberal supply of nitrogen, should therefore not be used on marsh lands, when the farmer has upland soil on his farm that needs a complete fertilizer. The amount of phosphorus and potash in 15 tons of barnyard manure, valued at about $1.50 per ton, can be applied in the form of potassium chlorid and rock phosphate at a combined cost of $7 per acre. This means a saving of about $15 per acre in fertilizer, besides the extra labor necessary to apply the manure.

Results of experiments showed a great variation not only in the total amount of phosphorus, but also in the readiness with which plants can extract that which does occur in the soil. Only by using phosphate fertilizers could satisfactory crops be grown. One of the most important factors influencing the solubility of phosphates in marsh, as well as in other soils, is the presence or absence of acid, acid soils as a rule being low in available phosphorus.

The cheapest form of phosphate fertilizer is the untreated ground rock phosphate, known as floats. This material is extensively mined in Tennessee and contains from 25 to 28 per cent of phosphoric acid (P_2O_5). It is not readily available to crops on some soils and is, therefore, very extensively treated with sulphuric acid to form acid phosphate, which is soluble and available to crops on all soils. The sulphuric acid, however, and the labor involved are expensive, so that where the natural rock phosphate can be used it is very much cheaper. The large amount of organic matter in marsh soils and its decomposition after drainage makes possible the use of untreated rock phosphate, which is acted on by the organic acids of the soil so as to cause it to become available. Nevertheless, it is well to make a rather heavy application at first since there is little danger of loss of phosphorus, and some time is necessary for it to become available. A half a ton per acre for the first application and followed by 400 to 600 pounds each three or four years thereafter is sufficient to supply the needs of heavy crops.

Ground steamed bone meal is also an excellent phosphate fertilizer for such lands, though much more expensive than the natural rock phosphate. Smaller quantities, however, are used at first than with the other form. From 300 to 500 pounds may be used at the beginning and each three to five years thereafter.

With most marsh soils the use of some form of potash fertilizer was found necessary to the maintenance of fertility. Either the muriate or sulphate of potash is recommended, the former being somewhat cheaper, and, except for certain crops, equally as good as the sulphate. Potatoes, tobacco, and sugar beets, however, have better quality when the sulphate is used.

Both these fertilizers are quite soluble so that it is unnecessary to make a larger application in the beginning as in the case of the rock phosphate above mentioned. The amount used, however, will depend upon the crops to be grown. Such rank-growing crops as beets and cabbage should have from 250 to 300 pounds of this fertilizer per acre; corn and potatoes, 150 pounds; and cereals and hay grasses, 100 pounds per acre. When these crops are grown in rotation it may be unnecessary to use the potash fertilizer in seeding down with a cereal crop following a crop on which a heavy application was used the previous year.

These fertilizers may be applied at any time and should ordinarily be spread broadcast and either plowed in, disked, or harrowed in so as to have them well distributed through the soil. On account of the small bulk of the fertilizer used, it can be applied readily by hand, in seeding grain or it may be mixed with the phosphate fertilizer when this is applied and distributed in one of the many fertilizer distributers on the market.

Where marsh soils were shallow and underlain by clay the potash content seemed to increase after a few years of cultivation—that is, a part of the necessary potash became available from the subsoil, whereas the need of nitrogen and phosphorus gradually developed, so that a complete fertilizer such as barnyard manure would be most helpful. Wood ashes gave very beneficial results on decidedly acid soils, the alkalinity of these ashes evidently causing the peat to decay more rapidly, thus furnishing available nitrogen.

A WEEDER HARROW FOR DRY FARMS.[1]

One of the prime requirements for successful dry farming is effective tillage implements which accomplish the greatest results with the least expenditure of labor. A homemade implement (fig. 1), which has been found very effective in dry farming in Utah, taking the place in a measure of the harrow, disk leveler, and weeder, is described by J. C. Hogenson, of the Utah Experiment Station, as follows:

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[1] Compiled from Utah Sta. Bul. 112; Deseret Farmer, 6 (1910), No. 33, p. 4; Transvaal Agr. Jour., 9 (1910), No. 33, p. 78; Dry Farming, by J. A. Widtsoe (New York, 1911, p. 313).

> The implement consists of a rectangle, 10 by 4 feet, made of 2-inch planks, 8 inches wide. To the under side of the 10-foot planks are bolted nine knives made from ¼-inch steel, 24 inches long. The steel is bent 8 inches from one end so that it will drop down behind the plank. The knives are bolted to the plank diagonally at an angle of 45° by means of two bolts. The bend is about 3 inches deep, which allows the knives to work that distance below the surface of the ground. The long part of the steel below the bend is sharpened on the front side so that weeds will be cut, this blade being about 13 inches long. The knives on the front slope to the right, while those on the rear plank slope to the left. This arrangement makes it impossible for any weeds to be missed, or any part of the ground to remain unstirred. The framework levels the land and crushes the clods, while the knives destroy the weeds and loosen the ground to the depth of 3 inches and form a perfect mulch.

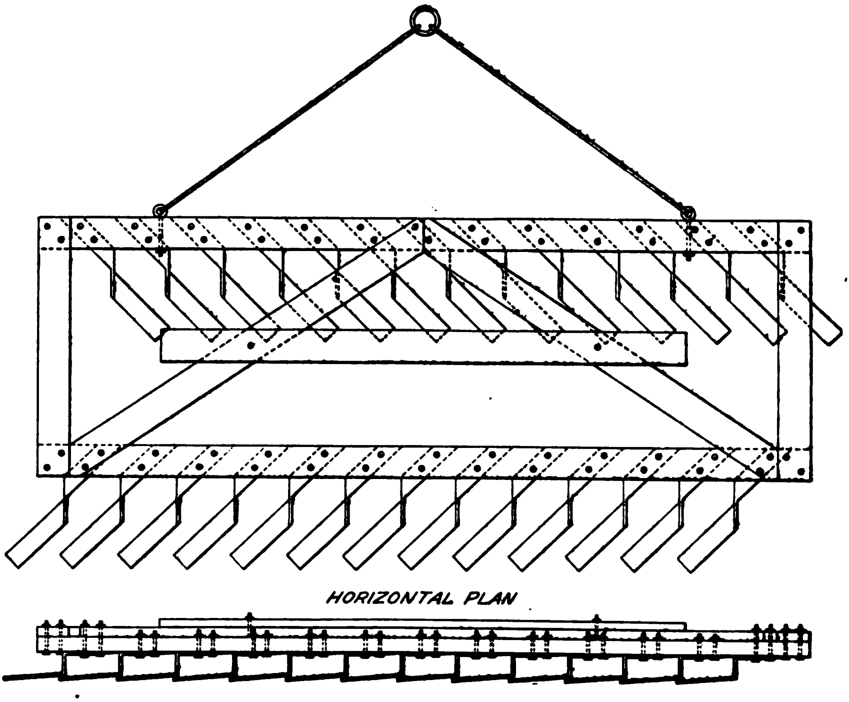

FIG. 1.—Simple form of a weeder harrow for dry farms.

An improved form of this implement (fig. 2) is described by Prof. Hogenson as follows:

> The frame of the implement is made of 4-inch channel steel, 6 by 4 feet. The frame is not made solid, but the 6-foot pieces are fastened to the 4-foot pieces by means of bolts so that the 6-foot pieces can turn freely. To make the

frame more solid, two iron-rod braces run diagonally from the front part of one 4-foot piece to the back part of the other. The weeder knives, 14 in number, are made of medium hardened steel, 3 inches wide by ¼ inch thick. Each knife is 22 inches long and is fastened to the 6-foot pieces at an angle of 45° by means of two bolts. Just behind the 6-foot piece a 3-inch bend is made in the knife, allowing it to drop horizontally below the frame. The front edge of the knife is sharpened. The knives on the front part of the frame, seven in number, slope to the right, while those on the rear part of the frame, seven in number, slope to the left. A lever attachment connects the two 6-foot pieces so that the knives can be raised or lowered at will. One 1¼-inch steel axle, 6 inches in length, is bolted to the inside of each of the 4-foot pieces so that when wheels are put on and the man is riding the machine is perfectly balanced and off the ground. Wheels are used only for transporting the implement to the field. The wheels are 18 inches in diameter with a 4½-inch face. The seat is placed on a bent spring on the 4-foot piece, to which the lever is attached.

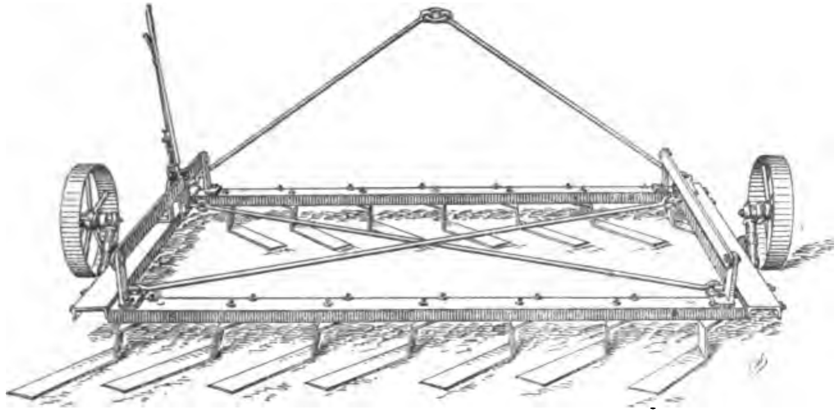

FIG. 2.—An improved modification of the weeder harrow.

Two horses can pull the implement readily. The doubletree is fastened to a ring, to which two iron rods coming from the front ends of the 4-foot pieces are attached. For summer-fallowed ground two of these implements can be run side by side, drawn by four horses, and manipulated by one man.

THE V-SHAPED COTTON-STALK CUTTER.[1]

The wisdom of destroying cotton plants early in the fall in the clean-culture method of combating the boll weevil[2] is generally admitted, but planters often fail to do this in the belief that it is an expensive operation, likely to interfere with other pressing farm work. W. Newell and M. S. Dougherty, of the Louisiana crop pest commission, describe a cheap and effective homemade implement which makes it possible for one man and two horses to cut, windrow, and burn

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[1] Compiled from Crop Pest Com. La. Circ. 30.

[2] U. S. Dept. Agr., Farmers' Buls. 344, p. 18; 457, p. 11.

10 to 15 acres of cotton stalks per day, at a cost of from 25 to 35 cents per acre on uplands and from 35 to 50 cents per day on alluvial lands. This implement, known as the V-shaped cotton-stalk cutter (figs. 3 and 4), has been in general use for several seasons in different sections of Louisiana. It may be made at home from the following materials:

2 pieces lumber, 4 by 4 inches, 9 feet long.
2 pieces lumber, 4 by 4 inches, 5½ feet long.

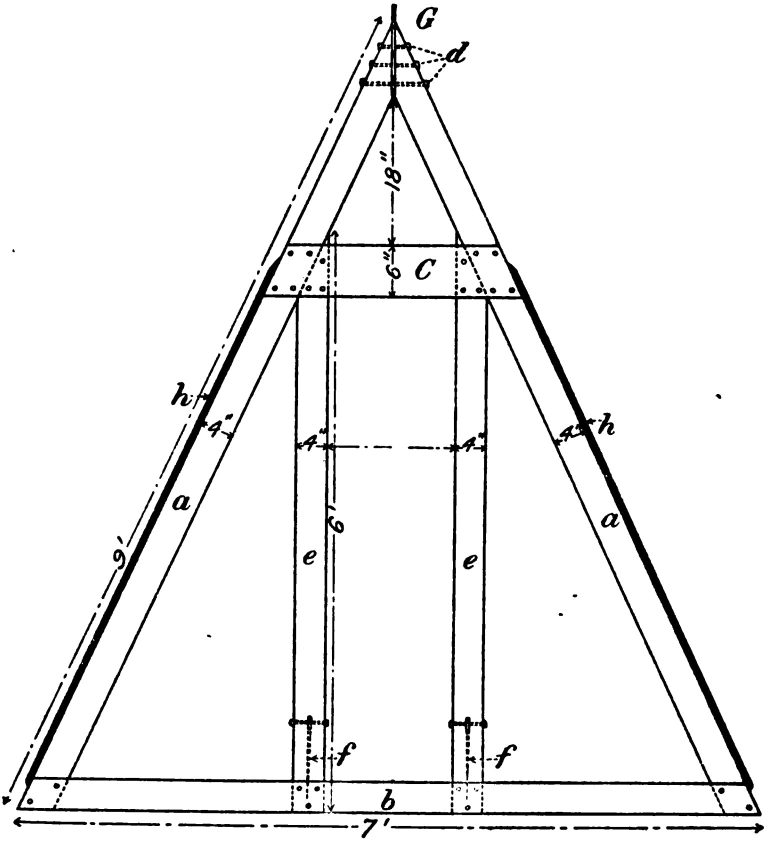

FIG. 3.—The V-shaped cotton-stalk cutter, top view.

1 piece lumber, 4 by 4 inches, 7 feet long.
1 piece lumber, 2 by 6 inches, 3 feet long.
1 piece of iron, ⅜ inch by 2 inches, 30 inches long.
2 pieces of iron, ⅜ inch by 1½ inches, 24 inches long.
12 bolts, ⅜-inch, 6½ inches long.
10 bolts, ⅜-inch, 4½ inches long.
1 bolt, ⅜-inch, 4 inches long.
1 bolt, ⅜-inch, 7 inches long.
2 bolts, ⅜-inch, 9 inches long.
45 bolts, ¼-inch, round heads, 4½ inches long.

45 large washers to fit the ½-inch bolts (needed if the blades are to be made from crosscut saws, as indicated below).

2 steel blades, about 3/16 inch thick, 3 to 4 inches wide, and 6 to 7 feet long, sharpened on one edge (or, better, two old crosscut saws from which to make the blades).

Only sound, well-seasoned cypress should be accepted. As the six pieces required contain about 50 board feet, the cost for lumber is usually about $1. The bolts required cost about 80 cents, the iron for making the clevis and rudders about 50 cents, and the steel blades about $1 each. If old saws are readily obtainable, they may be used and the price of the blades saved. The total cost for materials will, therefore, range from $2.30 to $4.30, depending on the variable local prices of lumber and hardware, and whether new material must be purchased for the blades. If the farmer has no forge it may be necessary to add the charges of a blacksmith.

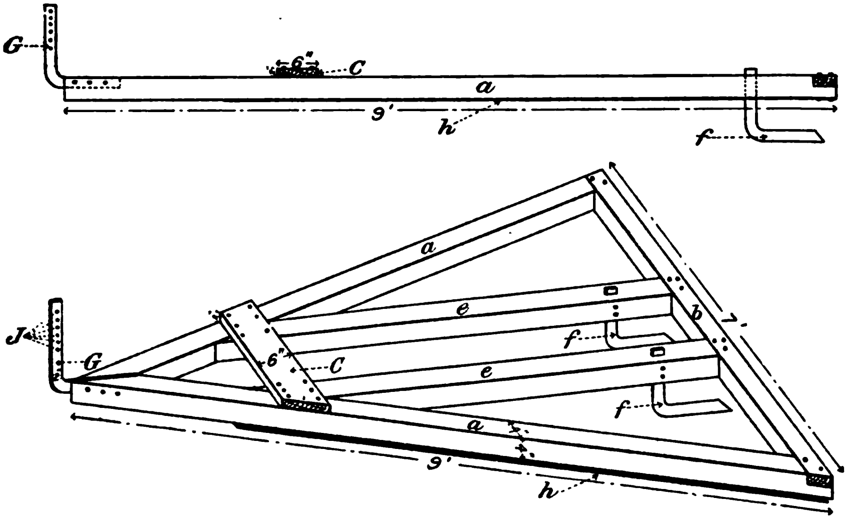

FIG. 4.—The V-shaped cotton-stalk cutter, side view and perspective.

The two 9-foot pieces of cypress (*aa*) and the 7-foot piece (*b*) should be cut and bolted together as indicated in figures 3 and 4. Before they are bolted together an opening should be chiseled in the top of the longer piece to receive the clevis attachment at *G*.

The clevis attachment is made by bending at right angles a piece of iron ⅜ by 2 by 30 inches. It is bent edgewise about 12 inches from one end. Three holes should be drilled 2 inches apart in the 12-inch arm to receive the 4, 7, and 9-inch bolts (fig. 3*d*) which fasten together the two 9-foot pieces of cypress (*aa*). Six ½-inch holes 1½ inches apart should be drilled in the upper portion of the 18-inch arm of the attachment clevis for use in hitching to the cutter and in regulating the depth at which the blades cut.

The rudders (*ff*) should be made of iron pieces ⅜ by 1½ by 24 inches, bent at right angles 8 inches from one end in the same manner as the clevis. The outer edge is beaten thin to cut through the ground without unnecessary friction. Six holes 1 inch apart should be drilled in the 16-inch arms of the rudders to permit them to be raised and lowered as the height of rows in the field varies.

The blades (*hh*) should be 6 or 7 feet long and wide enough to bolt firmly to the underside of the 4 by 4 pieces (*aa*) and still extend the cutting surface 1½ inches outside the wood. They should be of well-tempered steel. Old crosscut saws with the smooth edge filed to sufficient sharpness make excellent blades when securely bolted on.

When the side pieces (*aa*) and the base (*b*) are bolted together with ⅜-inch bolts, the clevis attachment should also be bolted in place. Additional bolts back of the clevis will add to the rigidity of the cutter. The 3-foot piece of 2 by 6 cypress (*C*) should next be bolted to the side piece (*aa*) and the 5½-foot piece (*ee*) bolted to it and mortised into the base (*b*), as indicated in figures 2 and 3. These are the rudder timbers and should contain openings about a foot in front of the base (*b*) of suitable size to receive the 16-inch rudder arms (*ff*). Two bolts through each rudder and rudder timber should hold the rudders in place. When in addition to these steps the blades (*hh*) have been securely bolted to the undersides of the side pieces the machine is completed. The blades should project 1½ inches and extend to the rear corners of the machine. If the blades are curved because made from crosscut saws, or from any other reason, they should be so set as not to project more than 1¼ inches to 1½ inches at the centers. In any case plenty of bolts should be used and absolute rigidity secured.

The stalk cutter is sometimes constructed with but one rudder and rudder timber. In this case the rudder is in the center of the machine, and runs half way between the rows where the ground is usually hard. It does not go deep enough to hold the machine steady and the lack of weight also contributes to unsteadiness. The two-rudder machine with the rudders running in the soft dirt at the sides of the rows go in deep enough to prevent skidding.

In using the cutter it is necessary to keep the blades very sharp by filing or other means. They should be so adjusted as to cut the cotton stalks at or just beneath the surface of the earth. Their depth is regulated by raising or lowering the chain by which the singletree is attached. If the machine runs too shallow the attachment should be raised to a higher notch in the attachment clevis (*J*, fig. 4). The rudders should be set deep enough to prevent skidding, but not deep enough to make the machine pull too heavily.

Where no fence surrounds the field two horses or mules should be hitched tandem to the stalk cutter in order that both may walk in the middle and pull steadily. If the field is fenced this arrangement will prevent cutting of the stalks at the ends of the rows and the two horses must be driven abreast. It is absolutely necessary that not a single green cotton stalk be left uncut in the field or at its edge if the weevils are to be starved. For this reason the field should be carefully gone over and every stalk that the machine has missed should be cut with a sharp cane knife.

STORAGE FOR ROOT CROPS.[1]

E. J. Delwiche, of the Wisconsin station, makes the following recommendations regarding the storage of roots for feeding purposes:

The best place to store roots is in a root cellar near where they are to be fed. Such a cellar may be a part of a barn, basement, or it may be built conveniently near to the stock barn. In most places the root house can be built most economically of concrete. Ordinarily cement is the only material that has to be purchased. The gravel and sand are usually available at no great distance on most farms. While the temperature in a root house should never fall to the freezing point, it should be at a low point for best results in keeping roots.

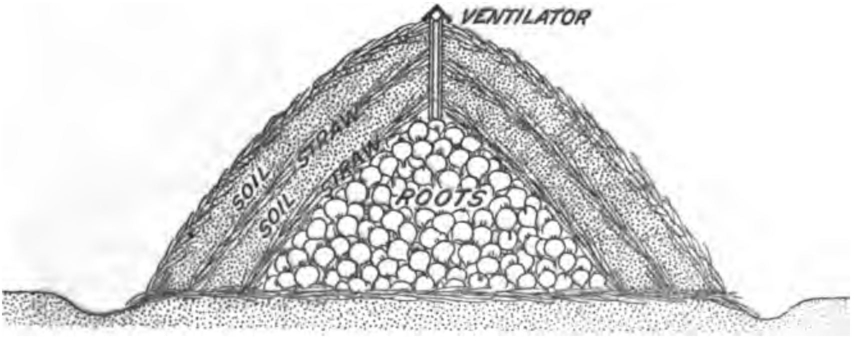

FIG. 5.—Cross section of an easily constructed pit for roots.

When no cellar is available, roots may be stored in pits. For fall and early winter feeding they need not be covered to any great depth. The roots are put in a conical pile about 4 feet in diameter on a bed of clean straw, then covered with a layer of 2 inches of long straw. Clean rye straw is preferred for this purpose. The straw at the apex of the pile is made to form a chimney 5 or 6 inches in diameter for ventilation. Dirt is thrown on the pile to a depth of 6 inches. The roots are piled as high as possible so as to shed water. When wanted for feeding the whole pit is taken into the barn at once. For early winter feeding the layer of dirt should be thicker, and in addition a covering of straw or horse manure should be placed over the whole pile.

Figure 5 illustrates a pit intended to remain over winter. This provides for two layers of straw and two of earth. A ventilator made of 4-inch boards is placed at the apex. When severe freezing weather sets in, the ventilator is stuffed tightly with fine hay. In such a pit roots will keep without freezing even in the coldest winters. If desired, the piles may be made oblong instead of conical in shape, retaining the gable form. While pits do very well, so far as keeping the roots is concerned, it must be understood that they are but makeshifts at best. A root house which is accessible at all times is much more satisfactory and more economical in the long run.

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[1] Compiled from Wisconsin Sta. Circ. Inform. 16.

A DANGER IN FEEDING ROOT CROPS TO BREEDING ANIMALS.[1]

The value of root crops for feeding farm stock is generally recognized, and their more extensive use in this country for this purpose is often advocated, but investigations carried on by L. G. Michael at the Iowa station suggest that caution should be exercised in the feeding of sugar beets and mangels to breeding animals, and that there is a sound basis for the opinion long held by stockmen "that sugar beets and mangels when fed to breeding animals will in some way cause the formation of renal and urinary calculi, or kidney and bladder stones." In a series of experiments with rams extending over five years it was found that "sugar beets and mangels favor the formation of renal and urinal calculi, or kidney and bladder stones, when fed to breeding rams"(figs. 6 and 7), and it is thought "very probable that these roots have the same effect when fed to ewes or to cattle." In view of the fatal results often attending the formation of these stones it is deemed inadvisable to feed sugar beets and mangels to breeding animals, but there appears to be no particular danger in feeding these roots "to fattening animals, as the calculi are not likely to develop sufficiently during the fattening period to cause serious results."

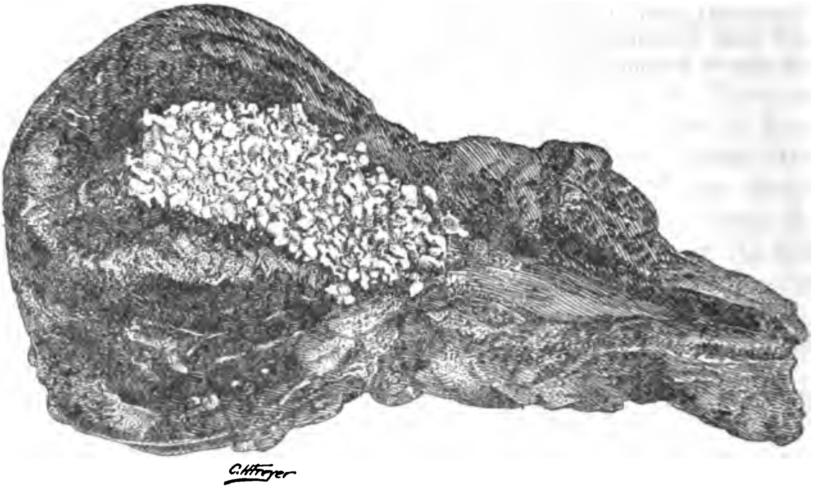

FIG. 6.—Bladder of ram containing many small calculi.

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[1] Compiled from Iowa Sta. Bul. 112, popular ed.

SANITARY CARE OF SWINE IN THE SOUTH.[1]

In a bulletin of the Virginia station, Dr. N. S. Mayo states that "swine raising promises to be one of the most extensive and profitable branches of animal husbandry in the South." He points out, however, that "at the present time large quantities of hog products are imported from other sections of the United States to supply the needs of the South." Climatic and seasonal conditions are especially favorable for the cheap production of pork of fine quality in many parts of the South, Dr. Mayo's statement applying particularly to that part of Virginia lying east of the Blue Ridge Mountains.

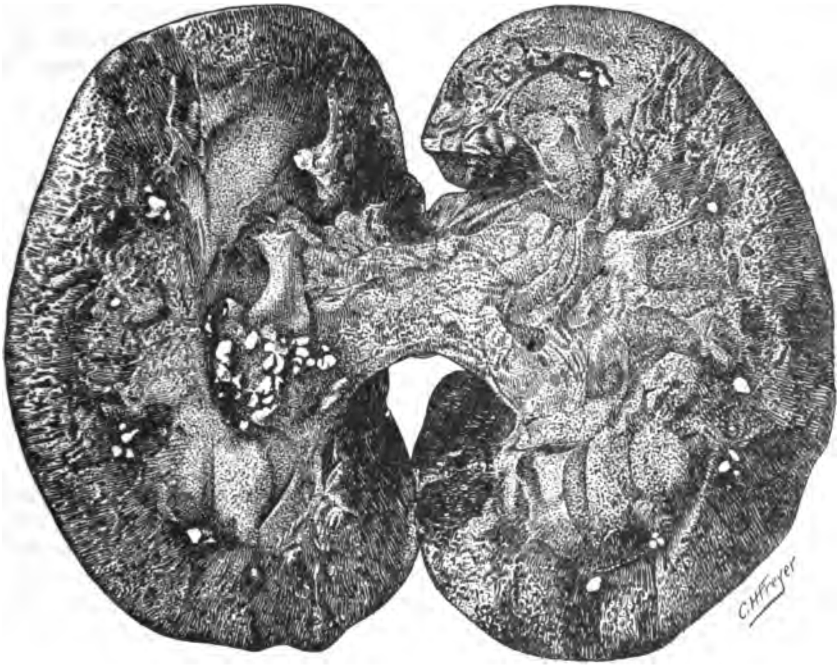

FIG. 7.—Kidney of ram showing presence of calculi.

SIMPLE SANITARY PRECAUTIONS.

There is no question as to the production of an abundance of cheap food, but as Dr. Mayo points out—

> In the successful raising of swine there are problems, other than that of feeding, which often determine success or failure. The most important of these is the preservation of the health of the swine. Wherever a considerable number of animals are gathered together the risk from disease is considerably increased. Extra precautions must then be taken to guard against disease and to keep the animals in thrifty condition.

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[1] Compiled from Virginia Sta. Bul. 189.

The first essential is that their quarters be kept clean and sanitary.

In purchasing swine, care should be taken that they come from herds free from transmissible diseases, that they are healthy, and have not been exposed to disease in transit. Public stock yards are liable to be infected with hog cholera; it is dangerous to bring swine from such places and put them in a healthy breeding herd.

It is an excellent plan to have a quarantine pen some distance from all other swine, and so located that there is practically no danger of transmitting diseases to the herd. All recently purchased animals should be held in quarantine in such a pen for ten days, to be certain that they are free from disease, before placing them in a healthy herd.

If a disease of swine occurs in the neighborhood, keep away from these farms and do not allow anyone who has been on an infected farm to visit your herd. If your swine have access to a stream of running water and disease appears on a farm located above yours, on the same stream, remove your hogs at once, as the infection is liable to be carried by the stream. Dogs and buzzards also are liable to carry the infection of hog cholera and should be kept away if possible. Such measures are simple, but they are very important.

RANGE FOR SWINE NECESSARY.

While a few swine can be raised confined in limited quarters, if such quarters are kept clean, they will do better, will keep in better health, and can be grown more cheaply if they have plenty of range for pasture. It is desirable to have the pasture fenced off into suitable areas so that the hogs can be shifted from one pasture to another, not only to provide fresh pasture, but also to afford an opportunity to disinfect the pastures, either by plowing and seeding to a forage crop or by exposure to sun and weather. Nearly all cases of intestinal worms, which are rather common in swine, are contracted from infected ground, and swine can be kept free from these parasites by frequent changes of pasture.

INEXPENSIVE SHELTER HOUSES CONDUCIVE TO HEALTH.

On account of the comparatively mild climate of Virginia, swine do not need the elaborate shelter that is necessary farther north. After experience with both permanent hog houses and small portable shelters that can be readily moved from place to place, we consider the small colony houses much superior, so far as maintaining the health of the swine is concerned, and they are also less expensive.

The walled type of hog house shown in figure 8 is well suited to southern conditions.

The walled portable house can be made about 6 feet square, 4 feet high in front, and 3 feet high at the back; a good opening for ventilation and a door 2 feet wide should be left in front. These can be closed by tacking coarse burlap sacks along the upper edge of the openings. The sacks are dropped in severe weather, or to exclude the sun. The roof or top should be removable to facilitate cleaning and to enable a person to enter the pen easily. The back edge of the roof can also be raised for ventilation. Such a pen is large enough for a sow and litter. It can be made larger to meet special needs, but it should not be too large to be easily moved from place to place.

Whichever type of house is used, it should have a good floor that can be easily cleaned and disinfected. In dry weather a dirt floor soon becomes worked up into fine dust that is injurious to pigs when inhaled; in wet weather it is difficult to keep the bed dry.

Bedding for swine should be scant, but of good quality. Forest leaves or corn husks make excellent bedding. Straw soon becomes ground into a dust that is irritating to the lungs and makes the pigs cough. When infected with germs it is liable to cause chronic pneumonia.

All hog houses should be kept clean; they should be thoroughly disinfected every two or three months and a coat of disinfecting whitewash applied.

The nature and treatment of mange, swine lice, bull nose (necrotic stomatitis), chronic pneumonia, hog cholera, and paralysis are discussed. The more common of these troubles are mange, lice, and cholera. For the first, dipping in lime-sulphur dip prepared as follows is advised: Slake 8 pounds of lime with sufficient water to make a thick paste. Sift in 24 pounds of sulphur and mix well with a hoe. "Put this mixture in a kettle with 25 or 30 gallons of water and boil for at least one hour; two hours is better. When ready for use, add sufficient water to make 100 gallons of dip. * * * This dip should be used warm—100° to 110° F." The dip is applied most effectively by means of a dipping vat.

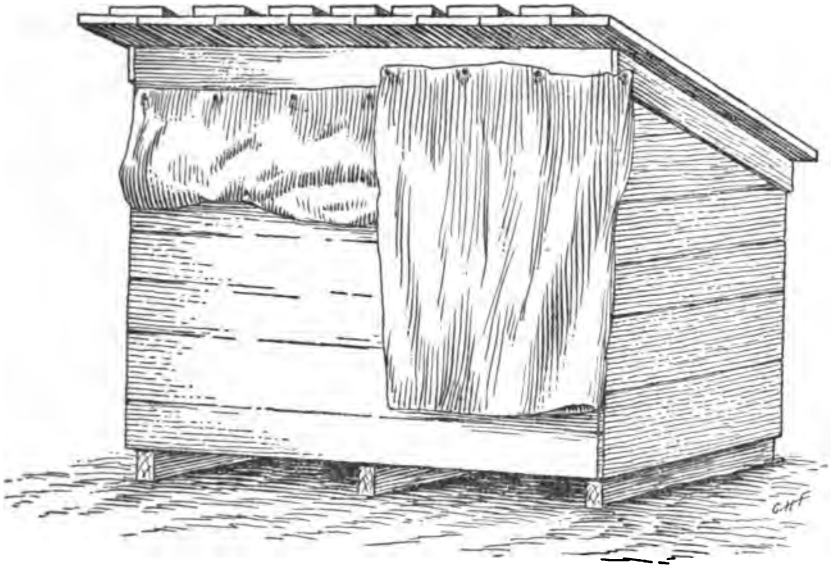

FIG. 8.—A walled portable hog shelter recommended for use in the South.

Dipping vats are made of wood, galvanized iron, or cement. They are set in the ground at a convenient place so that there is good surface drainage away from the vat. A good size for a vat is 10 feet long on top, 8 feet long on bottom, 1 foot wide on bottom, and 2 feet wide on top. The end where the hogs enter should be perpendicular and the other end inclined, with cleats, so that the hogs can emerge after swimming through. The entrance should be by a slide. Such a tank is very useful wherever hogs are kept in numbers, as frequent dipping tends to keep the hogs healthy and free from parasites.

For pigs and small shoats that can be readily handled, a barrel serves the purpose well; the pigs can be caught, plunged in the dip and held there the required time. Some successful swine raisers build cement bathing places or wallows for swine and keep these filled with a watery solution of some dip or disinfecting solution. If swine have wallowing holes filled with water some of the good dips should be put in these frequently.

After dipping or treating swine they should be placed in clean, uninfected quarters. To disinfect quarters, all litter and dirt should be thoroughly removed and scattered on land not frequented by swine. The floors, partitions, and other parts should be thoroughly saturated with one of the dipping solutions described above. They are best applied by means of a force pump which drives the solution into all cracks. After it is well dried the pens should be whitewashed, care being taken to fill all cracks well. An excellent disinfecting whitewash is made as follows:

An excellent disinfecting whitewash may be made as follows: Slake 25 pounds fresh lime in sufficient water to make a paste, sprinkle in 15 pounds of flowers of sulphur, add 30 gallons of water, and boil for an hour. Then add enough water to make 50 gallons, and apply with a spray pump, using a "Bordeaux" nozzle.

Dipping in coal-tar dips of the creolin type is an effective remedy for lice.

If the hog wallows are kept well filled with water, to which some of the creolin dips are added every ten days, the swine will usually free themselves from the lice. Another good way of combating the parasites is to tie gunny sacks or other coarse cloths around rubbing posts and keep these cloths saturated with crude petroleum.

The nature and treatment of hog cholera is fully dealt with in a Farmers' Bulletin of this department.[1]

INDIVIDUALITY OF THE COW AS A FACTOR IN ECONOMIC MILK PRODUCTION.[2]

Economy in milk production is of prime importance both to the producer and to the consumer. Examples of the wide range in the cost of production, due to a large extent to the individuality of the cow, have been previously given in this series.[3] The cause of this difference in individuality has been studied by the Missouri station, where careful comparisons were made of good and poor cows. Two Jersey cows from the same sire were found to digest their feed equally well, and both required about the same amount of feed for maintenance.

The real cause in the difference in production was found to be in the amount of feed consumed above that required for maintenance. During the year the better cow consumed 3,424 pounds of grain, 2,904 pounds of hay, 8,778 pounds of silage, and 4,325 pounds of green feed. The other cow consumed 1,907 pounds of grain, 1,698 pounds of hay,

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[1] U. S. Dept. Agr., Farmers' Bul. 379.

[2] Compiled from Missouri Research Bul. 2; New York State Sta. Bul. 322; Wisconsin Sta. Bul. 191.

[3] U. S. Dept. Agr., Farmers' Bul. 384, p. 16.

5,088 pounds of silage, and 2,102 pounds of green feed. In general the better cow consumed 1.7 pounds of feed for 1 pound consumed by the other cow, and produced 2.67 pounds of milk and 2.77 pounds of fat for each pound produced by the inferior cow. The better cow consumed 3.27 pounds of grain per day for maintenance, and the other 2.92 pounds. Both took hay and silage in the same proportion. The better cow required for maintenance for the entire period 1,200.8 pounds of grain, 1,204.5 pounds of hay, and 4,818 pounds of silage, which left available for milk production 2,233.2 pounds of grain, 1,699.5 pounds of hay, 3,960 pounds of silage, and 4,323 pounds of green feed. The inferior cow required for maintenance 1,065.8 pounds of grain, 1,065.8 pounds of hay, and 4,292.4 pounds of silage, leaving available for milk production 841.2 pounds of grain, 632.2 pounds of hay, 795.6 pounds of silage, and 2,102 pounds of green feed. These figures show the large amount of food left for milk production in the better cow, which was 8,522.9 pounds of milk, containing 5.51 per cent fat. The other cow produced 3,188.9 pounds of milk, containing 5.31 per cent fat.

Data are presented of two other cows kept for an entire lactation period under identical conditions as those above described. * * * The feed consumed during the lactation year minus the estimated maintenance is the amount considered available for milk production. The ratio between the food available for milk production and the milk produced is practically the same with each of the four cows. The available feed consumed and the milk solids produced are also calculated in calories in order to reduce all to a common basis. * * * The main difference between profitable and unprofitable dairy cows is not to be found in the coefficient of digestion, or in the amount of food required for maintenance. A superior dairy cow is simply one with a large capacity for using food above the maintenance requirement and one that uses this available food for milk production.

A further illustration of the difference in the individuality of cows is shown in the records of a herd kept at the New York State station. The best cow in the herd averaged 10,150 pounds of 4 per cent milk annually for three years on $58 worth of food. The poorest cow averaged 3,350 pounds of 5.85 per cent milk on 52.40 dollars' worth of food. If in one year the poorer half of the herd had been replaced by animals equal to those in the better half it would have increased the yearly station revenue $237.40, if the milk had been sold at current shipper's prices, or $379.90 if the milk fat had been sold, with an added expense of only $40, the cost of the extra food consumed by the better cow.

The practice of officially testing dairy cows has proven to be an efficient factor in weeding out the unprofitable members of the herd. The Wisconsin station has published during the year results of official testing in that State for the past 10 years. During the first 5 years of the decade the average production of aged Holstein cows on a 7 days' test was 397.5 pounds of milk and 13.9 pounds of milk fat, while in the last 5 years of the decade the average production of this class was 432.9 pounds of milk and 15.3 pounds of milk fat. This gain was due in large part to improved breeding, feeding, and selection of the dairy stock.

HATCHING AND REARING TURKEYS BY ARTIFICIAL METHODS.[1]

Notwithstanding the popularity of the turkey for human consumption and its consequent high price, the turkey producers have not been able to supply the demands of the market, due to the fact that turkeys are more subject to diseases than chickens and because the care of the young poults requires much patience on the part of the poultryman. Nevertheless, turkey raising returns a good profit to the producer when properly handled. In Farmers' Bulletin 200 the problems connected with raising turkeys have been outlined and treated more or less in detail. In a previous number of this series[2] precautionary measures for preventing the disease known as blackhead are outlined.

The results obtained in the following experiment, conducted by the Washington station, on hatching and rearing turkeys by artificial methods should prove of value to those who desire information on the care of young poults.

Setting the machine.—About the 1st of June we secured 102 turkey eggs of the Mammoth Bronze variety, which nicely filled the tray of our 150-hen-egg incubator. The machine had previously been warmed in the usual way, and at the time the eggs were placed in the tray the thermometer registered 102°. The moisture pan, which was the same size as the tray and located beneath and 2 inches from the tray, was supplied with sand one-half inch in depth, which was thoroughly saturated with warm water. This sand was kept wet enough to show puddles of water on its surface at all times during incubation, by daily applications of water heated 100 to 103° F.

Turning the eggs.—The eggs were turned once every 12 hours—morning and evening—beginning on the third day after they were placed in the tray and continued until the first sign of hatching, the pipping of the egg. The turning was very carefully done by first removing from the center of the tray about 1 dozen eggs, and then carefully rolling, with the hand, the remaining eggs toward the center of the tray, just enough to change the position of each egg. The eggs that had been removed were then placed in either end of the tray.

Temperature.—During the first week a temperature of 102° was maintained, and afterwards 103°, with but slight variations.

Testing.—On the tenth day the eggs were tested for fertility, 4 clear eggs being found, which, with the 3 that were cracked in transit, left for the machine just 95 eggs. Of these, 4 more were taken out, at the second testing, which occurred on the twentieth day. Thus we had 91 eggs that had stood the test.

Hatching.—The first evidence of hatching occurred on the evening of the twenty-seventh day, and by the evening of the twenty-eighth day the hatch was complete, resulting in 87 poults—4 had died in the shell. The day following the hatch the incubator door was left ajar about one-eighth of an inch, which was increased the second night to one-quarter of an inch. This was done to gradually harden the poults in their preparation for the hover.

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[1] Compiled from Washington Sta. Bul. 96.

[2] U. S. Dept. Agr., Farmers' Bul. 334, p. 27.

Brooding.—During the afternoon of the second day after the hatch the poults were placed in a hover in the brooder house. The hover had been warmed to a temperature of 90°. The poults appeared well and bright. All were placed in one hover, which proved to be a mistake, for the following morning there were several dead ones, caused by the young things deserting the hover and piling up, many of the underneath ones being smothered. About 30 were thus lost in a few hours.

When reared in the natural way and seeking to be hovered, the poults instinctively duck their heads and creep under the mother hen, while she assumes a settling position. The poults having thus assembled they become distributed among the feathers and under the wings of the hen. The warmth from the hen's body satisfies them. They become quiet. Deprived of the mother hen they bunch when, in their search for warmth, a scramble ensues, each poult making a desperate effort to get under the bunch. In the struggle they become surprisingly entangled, causing a condition that brings death to the weakest ones from smothering.

In order to save the remaining poults they were divided among three hovers, which ended the losses. These hovers were at first kept at about 90° temperature for about a week, when they were reduced in temperature about 10° weekly, until down to 70°, which temperature was maintained until the poults were about six weeks of age, after which time they do not require artificial heat. They were permitted to occupy the hovers for a couple of weeks longer, when the hovers were removed entirely. Care had been taken in keeping the hovers scrupulously clean by removing the dirt and supplying clean chaff. After removing the hovers, the poults were confined to their nursery rooms, each 4 by 12 feet, with an outside runway 4 by 20 feet It was found necessary to provide additional runways as they rapidly outgrew those they were occupying. At four months of age they were given their liberty. They would not range, nor travel but a few rods from the place where they had been confined.

Feeding.—Unlike chickens, the young poults appeared not to know where to find their food. Teaching them to eat promised to become quite a problem. Failing to attract them to their feed in other ways, a few young chicks were placed in the nursery with each flock of poults. It was surprising how aptly they took their first lessons from the chicks. Within one hour the problem was solved and all were feeding and drinking, with no further trouble. The first feed was stale bread, moistened with sweet milk, chopped onion tops, grit, and pure water. At this time the poults were nearly three days old. About three days later their bread feed was gradually changed to commercial chick feed, cooked milk curds, and lettuce. Three or four days later there was added to this feed dry bran and beef scraps—five parts bran to one part scraps—mixed and placed within their reach in shallow boxes, which was kept before them all the time until they became five months of age. A convenient hopper for this dry bran feeding we find to be a box 4 feet long, 6 inches wide, and 6 inches deep, with a strip 2 inches wide, nailed lengthwise and in the middle along the top. Supply this hopper daily, just enough for a single day's feed—all that the poults will eat. Fresh green stuff, such as lettuce, kale, or cabbage, was fed liberally daily, morning, noon, and evening; also sweet milk and fresh water. The drinking vessels were washed clean daily. A box of gravel and cracked shells and a dust bath were kept in their nursery. From the time they would pick up oats, corn, or wheat their grain ration consisted of equal parts of these grains, mixed and scattered in the runway three times daily, as much but no more than they would eat. We regard that the most surprising thing in connection with the feeding was the small quantity of these grains consumed, which was evidently due to the very liberal supply of milk and green stuff provided.

Preparing for market.—Two weeks before these turkeys were to be marketed for the Christmas trade they were weighed separately, when one-half of the number were divided into lots of four each and placed in darkened pens, admitting the light only at feeding times, while the remaining one-half were confined in roomy roosting quarters, having a runway of 20 by 50 feet. These quarters were not darkened in any way. Both lots, in lieu of the mixed grain and dry bran feed, were fed three times daily of the following fattening ration—all they would eat—making the change gradually: 6 parts corn meal, 2 parts middlings, 2 parts beef scraps, by weight, and moistened with milk. The green feed was fed as before.

This experiment lasted two weeks. The birds that were confined in darkened pens made no gain whatever in weight, while those birds that had more liberty gained 2 pounds and 2½ pounds each. These birds were marketed when a little more than 5½ months of age, when the pullets weighed 13 and 14 pounds each, and the toms 17 to 19 pounds each, live weight.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 466.

WINTER EMMER.

BY

MARK ALFRED CARLETON,
Cerealist in Charge of the Office of Grain Investigations,
Bureau of Plant Industry.

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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 24, 1911.

Sir: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript entitled "Winter Emmer," prepared by Mr. Mark Alfred Carleton, Cerealist in Charge of the Office of Grain Investigations.

In recent years the cultivation of emmer in the United States has come to be of considerable importance. Heretofore almost the entire bulk of the crop has been made up of spring varieties. In localities where spring grain is not well adapted there is always need of fall-sown varieties. The accompanying paper will therefore be of value to farmers in such districts.

Respectfully,
B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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WINTER EMMER.

INTRODUCTION.

Emmer has been grown to a considerable extent as a profitable field crop in portions of this country for 15 to 20 years and was known to northwestern farmers probably as early as 1875 or 1880. In recent years its cultivation has greatly increased and it is now found worthy of a place in statistics. There are both spring and winter varieties, but the emmer crop of the United States heretofore has been almost entirely spring sown. This paper treats of winter emmer and the importance of using winter varieties for certain conditions and in certain districts. The general description of emmer, its history, etc., are applicable equally to spring or winter varieties.

USE OF INCORRECT NAMES FOR EMMER.

It is again necessary to protest strongly against the use of incorrect names for emmer, as writers who are supposed to be well informed still persist in using them. The most common word thus wrongly used is "speltz," which does not even exist as a legitimate word in any language. What is meant is the German word "spelz," which is spelled differently and which is translated "spelt" in English. True spelt, however, differs as much from emmer as pears differ from apples. The difference between emmer and spelt is shown in the accompanying illustrations (figs. 1, 2, and 3). The third specimen (*c*) in figure 1 is Black Winter emmer.

CHARACTERISTICS OF EMMER.

Emmer is a species of wheat, known botanically as *Triticum dicoccum* (*T. amyleum*). The plants of this species are pithy or hollow, with an inner wall of pith; leaves sometimes rather broad and usually velvety hairy; heads almost always bearded, very compact, and much flattened at the 2-rowed sides. The appearance in the field is quite different from that of spelt. The spikelets (that is, the unhulled grains as they come from the thrasher), however, look considerably like those of spelt, but differ principally in the presence always of a short, pointed pedicel. (Fig. 2.) This pedicel, which is really a portion of the rachis (stem) of the head, if attached at all to the spelt spikelets, is always very blunt and much thicker. Usually, however, its pedicel does not remain attached to the base of the spelt spikelet after thrashing; instead, each spikelet carries on its inner face the pedicel belonging to the next spikelet above. (Fig. 3.) Besides, the emmer spikelets are flattened on the inner side and not arched as in spelt, so that they do not stand out from the rachis as the spelt spikelets do, but lie close to it and to one another, forming a solidly compact head. The spikelets of spelt, on the other hand, are placed far apart and, being arched on the inner side, stand out from the rachis, forming a very loose head. The spikelets of emmer are usually two grained, one grain being located a little higher than the other. The outer chaff is boat shaped, keeled, and toothed at the apex. The grain is somewhat similar to that of spelt, but is usually harder, more compressed at the sides, and redder. Emmer is a more hardy plant than spelt in every way. Almost all varieties of emmer are considerably resistant to drought, and certain varieties are very resistant to rust. Moreover, emmer is a crop adapted to general conditions, more so than other cereals, and will withstand to a considerable degree the effects of wet weather in humid climates. (Fig. 4.) Fall-sown varieties are also quite winter hardy. Emmer will produce a fair crop under almost any condition of soil and climate, but thrives best in a dry prairie region with hot summers, where it gives excellent yields.

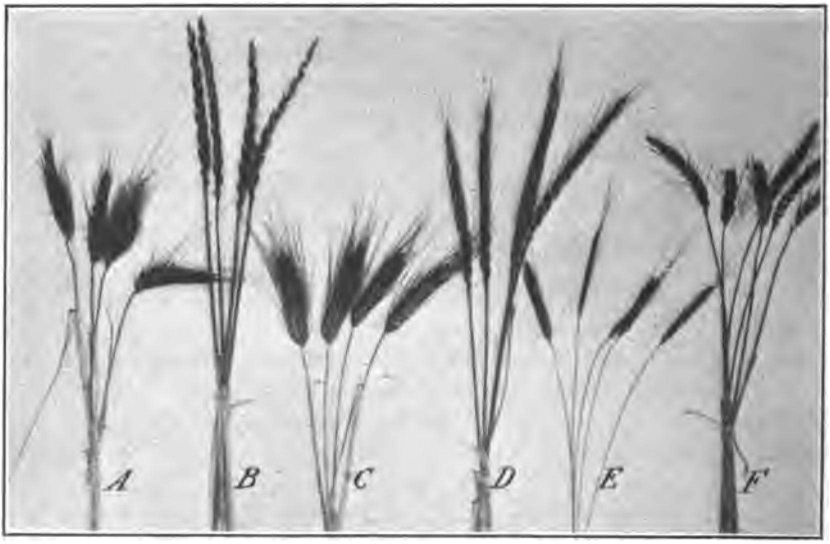

FIG. 1.—Heads of German emmers and spelts: *A*, Black Winter emmer with compound heads; *B*, white beardless spelt; *C*, Black Winter emmer; *D*, black bearded spelt; *E*, double einkorn; *F*, spring emmer.

DISTRIBUTION OF EMMER.

The origin of emmer as a cultivated plant dates back to prehistoric times, without much question. It was probably derived from einkorn (*Triticum monococcum*), a still simpler form of wheat, which apparently originated in southeastern Europe and which has very narrow, compressed heads, with usually but one grain to the spikelet.

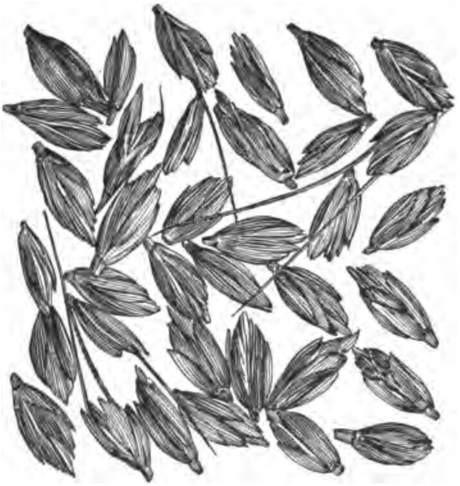

FIG. 2.—Emmer spikelets, showing short and pointed pedicel attached to base.

Emmer seems to have been found first in Switzerland and is grown in that country at present. It is also grown in Servia, Germany, Russia, Spain, and Abyssinia, and to some extent in France and Italy. A rather large quantity of emmer of excellent quality is produced in Russia each year. All our best seed of spring emmer is obtained from that country, and when grown in our northwestern plains yields a grain entirely equal in quality to that of the original. The average annual production of emmer in Russia is about 10,000,000 bushels. The climate of the upper Volga region seems admirably suited for the growth of this cereal. The varieties grown there are almost wholly of the white-chaff group. In north Caucasus a considerable quantity of red-chaff emmer is produced. Emmer is also grown in Germany to a considerable extent, as is true spelt, hence the two cereals have been much confused, and it is partly for that reason, probably, that there has been such a confusion of names in other countries, into which both emmer and spelt have been introduced from Germany. Several varieties of emmer are grown in Servia, including an excellent white-chaff sort. Often the

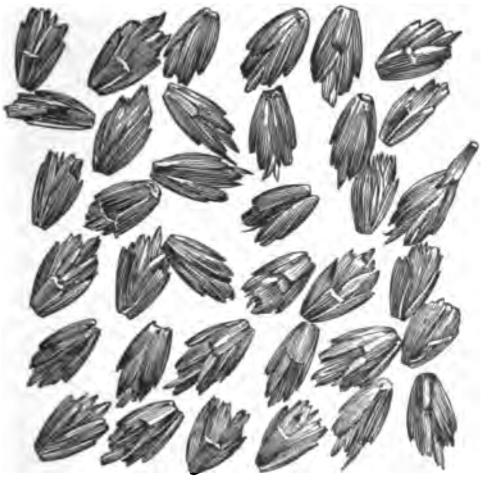

FIG. 3.—Spelt spikelets, mostly without pedicel attached to base, but usually with the pedicel of the next spikelet attached to face.

heads in the Servian varieties are rather small. The annual production of emmer in Servia is considerable. Varieties of the white, smooth, bearded group are mostly grown in Germany, Switzerland, France, and Italy. In Abyssinia several interesting varieties are grown at altitudes of 5,000 to 9,000 feet. Judging from certain statements in official reports, the inference is that emmer is also grown in northern India, Tibet, and portions of China, but it has not yet been introduced from those regions into this country.

CULTIVATION OF EMMER IN THE UNITED STATES.

In a previous bulletin, the writer[1] entered into a general discussion of emmer, referring especially to spring varieties. Certain tests of spring emmer made by different farmers are mentioned, as well as trials at agricultural experiment stations. The results of these trials are summed up briefly on page 11 of the bulletin cited, as follows:

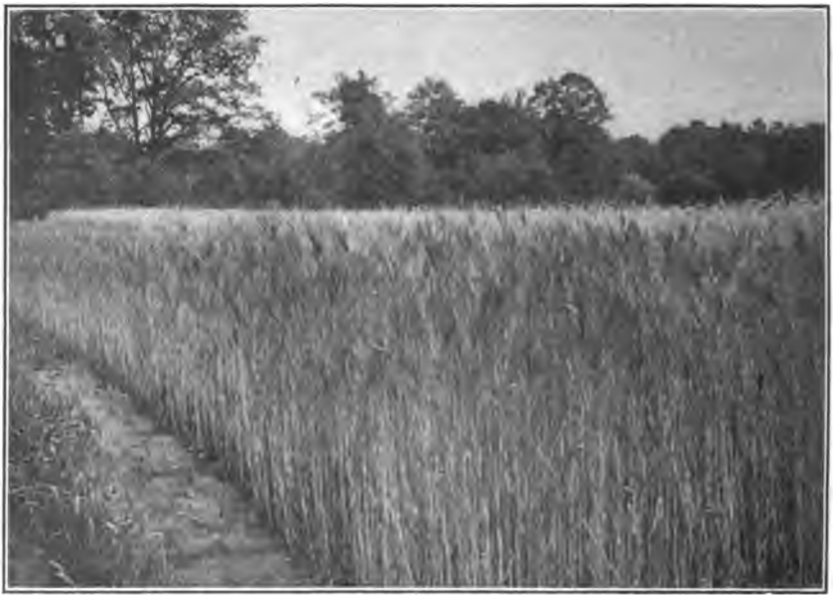

FIG. 4.—Black Winter emmer (G. I. No. 2337) at the Maryland Agricultural Experiment Station, June 21, 1906.

> From the trials so far made of emmer, both at the experiment stations and on farms, as well as the plat experiments of this Department, one may draw the following conclusions with respect to its success in cultivation in this country: (1) It is most successful in the Great Plains region, particularly the northern portion, in the Palouse country, and in northern portions of the irrigated districts; (2) in other parts of the country, however, it will often compare well with other crops, and is especially able to escape

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[1] Carleton, M. A. Emmer: A Grain for the Semiarid Regions. Farmers' Bulletin 139, U. S. Dept. of Agriculture, 1901.

damage from continued wet weather at harvest time; (3) it stands up well in the field; (4) it is usually very resistant to the attacks of leaf rust,[1] smuts, and other fungi; (5) it is very resistant to drought; (6) in districts where it is otherwise adapted it gives excellent yields; (7) true winter varieties, of which there are not many, resist rather hard winters.

As already stated, emmer, though resistant to drought, and having been introduced more especially for use in semiarid districts, is also fairly well adapted to humid areas; in fact, it is a general-purpose crop with reference to climate and soil. However, in the humid areas and in other districts where the winters are not severe, winter grains are always much more profitable than spring grains where the former can be grown, as they give much better yields and by ripening early often escape the effects of rust, and they also appear to escape attacks of some insects, and may also furnish fall and winter pasturage. It was therefore desirable to introduce and test winter varieties of emmer if these could be obtained.

INTRODUCTION OF WINTER EMMER.

It was known to the writer for some time that winter emmer existed in southern European countries all the way from Spain eastward to Servia. One variety in particular, the Black Winter emmer, has been for many years advertised by a seed firm in Paris, and small samples received from that firm at different times have been planted in the nursery rows of our experimental plats. It was decided to obtain more seed and give this variety a thorough trial. Therefore, in August, 1904, 36 kilos, or about 79 pounds, of seed of Black Winter emmer were obtained from the seed firm mentioned and planted that fall. From the resulting crop the seed was increased from year to year (figs. 4 and 5) and finally distributed under G. I. No. 2337, to experiment stations and a number of farmers throughout the country. The results of all trials made since that time to date have been generally good, though there have been occasional disappointments.

Several varieties of winter emmer are grown in southern Europe. Aside from minor characters these varieties differ from the spring emmers in having a considerably larger head, particularly broader, and a larger and stiffer stem. The leaves and chaff are velvety, that is, covered with many small hairs. There is a good root development and the habit of growth of the plant is that possessed by all winter cereals. The velvety character of the plant, as well as other peculiarities in the structure of the leaves and stem, probably accounts for the fact that this crop is resistant to the effects of wet seasons in the humid areas and also resistant to drought.

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[1] A few varieties have been found to rust considerably in certain instances.

ADAPTATION OF WINTER EMMER IN THE UNITED STATES.

Trials of winter emmer have been conducted on experiment farms and quite a number have also been made by farmers.

TRIALS ON EXPERIMENT FARMS.

While emmer has been grown for one or two years in a number of places, the grain-experiment farms controlled wholly or in part by the United States Department of Agriculture have not been running a sufficient length of time to permit tests to extend over any considerable number of years. The only very extensive series are the trials made at the Amarillo (Tex.) Experiment Farm and on the cooperative experiment farm conducted until recently at McPherson, Kans. Even at the Amarillo Experiment Farm the series covered only three years, viz, 1906 to 1908, inclusive. The yields for these three years were as follows:

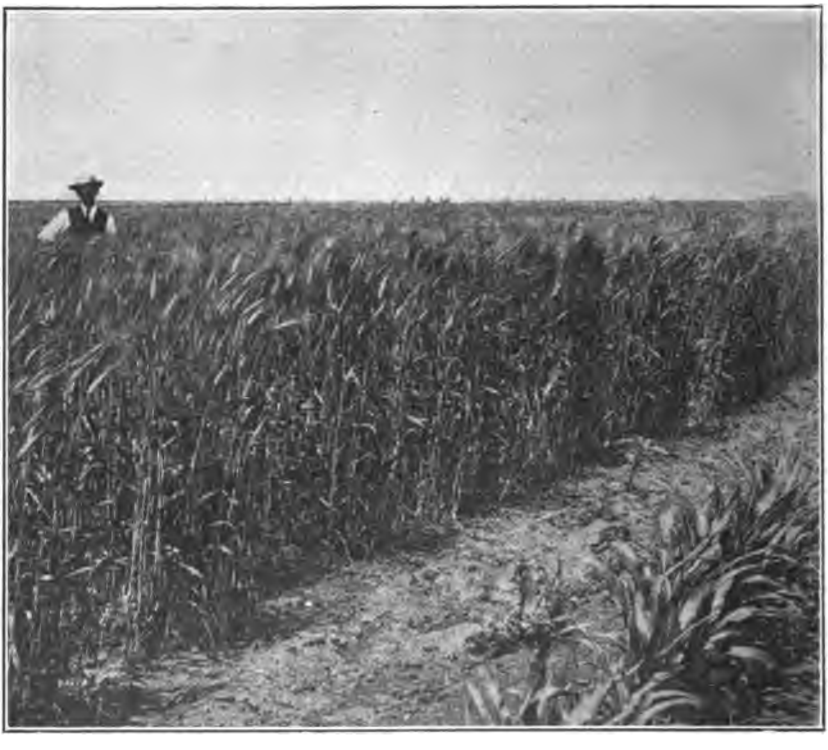

FIG. 5.—Field of Black Winter emmer (G. I. No. 2337) at the United States Experiment Farm, Channing, Tex., June 14, 1906.

TABLE I.—*Yields of winter emmer at the Amarillo Experiment Farm, 1906–1908, inclusive.*

G. I. No.	Yield (in bushels).				
	1906	1907	1908	Average.	
				3 years.	2 years.
2337	42.07	32.25	23.30	32.54	....
2483	....	50.37	17.29	....	33.83

At the McPherson (Kans.) Cooperative Experiment Farm tests with winter emmer were made covering the five years from 1905 to 1909, inclusive, with results as follows:

	Bushels.
1905	18.75
1906	53.33
1907	31.10
1908	77.00
1909	47.20
Average for 5 years	45.47

Mr. V. L. Cory, in direct charge of the experiments at McPherson, in a recent report comments as follows on emmer as grown on this farm:

> Neither einkorn nor spring emmer, so far as tested, is of value. On the other hand, our results demonstrate the value of winter emmer. It is resistant to cold and drought, coming through the severely cold and dry winter last year (1909) with a survival of 50 per cent and giving a yield of 47 bushels per acre.
>
> With this grain there is a certainty of producing a fair crop that does not exist in either barley or oats. In bushels per acre it yields more than any other of the small grains, and in pounds per acre it is only outyielded by wheat, which can not be considered as a feeding crop. Again, emmer is scarcely susceptible to leaf rust and not at all to the smuts, and is not readily damaged by harvest rains. If not harvested at early ripening, stem rust usually attacks the plants, but too late to cause much damage.
>
> Emmer and spelt are used for feeding to live stock and compare favorably with oats and barley for that purpose. The large yields produced by these two winter cereals indicate that these grains may be of considerable value in central Kansas for furnishing stock feed.

Before beginning operations at the Amarillo (Tex.) Experiment Farm, investigations had been conducted for three years at Channing, Tex., and during two of these years, 1905 and 1906, Black Winter emmer (G. I. 2337) was grown, giving yields of 47.10 bushels per acre in 1905 and 31.10 bushels in 1906 (fig. 5), or an average for the two years of 39.10 bushels. Concerning this crop at Channing, Mr. A. H. Leidigh, then superintendent of the experiments, commented as follows in a report for the year 1906:

> The Black Winter emmer (G. I. No. 2337), also of foreign origin, while not making as striking a showing in 1906 as in 1905, is undoubtedly a valuable introduction and would have shown a higher yield if it could have been cut at the proper time the past season.

In the cooperative grain experiments conducted at Nephi, Utah, between this Bureau and the Utah experiment station, Black Winter emmer has been grown three years with the following yields: 1908, 41.33 bushels; 1909, 42.49 bushels; 1910, 32 bushels. The average for the three years was 38.6 bushels. The weight per bushel has been so far about 30 pounds. In Circular No. 61 of the Bureau of Plant Industry, entitled "Dry-Land Grains in the Great Basin," pages 15–16, the author, F. D. Farrell, comments as follows on this crop:

> Its ability to resist drought has been satisfactorily demonstrated and at Nephi it has proved extremely hardy. * * * The hardiness and drought resistance of Black Winter emmer and its high yield and excellent feeding qualities make it a particularly desirable grain for dry-land farmers who wish to raise their own stock feed.

Black Winter emmer was grown in cooperative experiments conducted with the State experiment station in California during four seasons, 1906 to 1909, inclusive. These experiments were in duplicate at Modesto and Yuba City. The Yuba City experiments in 1908 were transferred to Davis. The yields of the winter emmer at Modesto were as follows: 1906, 13 bushels; 1907, failure; 1908, failure; 1909, 35.3 bushels. Counting the total failures the average for the four seasons was 12.7 bushels per acre. The results at Yuba City and Davis were: 1906, 13.7 bushels; 1907, 24 bushels; 1908, 12.6 bushels; 1909, 52 bushels. The average yield for the four years was 25.6 bushels per acre. The results were therefore fair at Davis and Yuba City, but unprofitable at Modesto.

As previously stated, winter emmer has been tested at several of the State experiment stations, but in no case has there been any considerable number of trials. The few tests that have been made at stations south of the fortieth parallel have as a rule given satisfactory results. No doubt a considerable number of instances with positive results would have been obtained in experiment-station trials if more attention had been given to its distribution in southern latitudes. The idea at first was that winter emmer would be adapted to withstand winters rather more severe than appears to be the case. On looking up the matter more recently it appears that in all tests of winter emmer in European countries it has been found that, although a winter crop, it will not withstand as severe cold as some of the hardier common winter wheats.

TRIALS BY FARMERS.

Winter emmer has not yet been given a very wide distribution. Nevertheless, a number of farmers have had opportunity to grow it, and wherever careful attention has been given and the winters are not particularly severe results have usually been good.

Mr. George W. Oster, of Osterburg, Pa., grew winter emmer in 1908–9 and obtained a yield of 45 bushels per acre. No rust, smut, or insects of any kind affected the crop.

Mr. R. T. Bennett, of Wadesboro, N. C., obtained a yield of about 25 bushels per acre in 1907, when wheat on the same farm yielded 12 bushels per acre. In that locality, of course, winter emmer is winter proof. Mr. Bennett made the comment that "stock prefer the emmer to oats and no weather is too frosty for it."

Mr. A. L. Dunlap, of Lupton, Mich., obtained a yield of 12 bushels per acre in 1910, when the preceding fall from seeding time until winter was very dry. He states that the crop is "very good; better than oats." It weighed 40 pounds per bushel.

Mr. D. L. Davis, of Zenia, Cal., grew winter emmer during the year 1909–10, sowing broadcast at the rate of 70 pounds per acre. A yield of 31 bushels per acre was obtained. Mr. Davis remarks in a report that "it is a great drought resister. It stood the drought equal to rye. It is the surest crop I have found in eight years' trial of grain here. The straw is soft. It fills well, stands up good, and yields better than barley or rye." In February, 1911, Mr. Davis wrote in response to an inquiry from this office: "I have sold every bit of the emmer. I have not even a sample on hand. The people come for 25 miles for seed."

As showing the adaptation of this crop to dry districts it is interesting to report that Mr. S. A. Figart, of Johnson, Stanton County, Kans., in the extreme southwestern part of the State, obtained a yield of 60 bushels per acre in the summer of 1907 from a seeding of only half a bushel per acre. The crop was drilled and was no doubt given good attention in other respects. The same season the other crops of Mr. Figart yielded as follows: Corn, 30 bushels; wheat, 5 bushels; white spelt (true spelt, not emmer), 15 bushels. It should be remarked that a crop of this kind giving such yields is of the greatest importance in this district, where the conditions are such that stock raising must be practiced to a large extent, and emmer has already proved to be an excellent stock feed, easily taking the place of barley, rye, or oats.

EXPERIENCE WITH BLACK WINTER EMMER ON A WYOMING FARM.

The most interesting trial of winter emmer, outside of those conducted on the Federal and State experiment farms, is that on a farm at Worland, Wyo., by Prof. B. C. Buffum, who was formerly director of the State agricultural experiment station at Laramie, Wyo. Having had much experience in experiments with grains as well as other crops, an account of his results with this cereal will be read with much interest.

In the summer of 1907 Prof. Buffum obtained about 2 quarts of Black Winter emmer from the Office of Grain Investigations of this Department and has recently reported his results with this crop, as follows: Portions of this seed were planted at intervals during August and September on sagebrush bottom land which had been prepared in July; the soil being then dry and loose, the land was thoroughly irrigated before planting. The crop from the earliest planting was 5 to 7 inches in height at the beginning of winter. In the spring of 1908 it was found that only 72 plants had survived, the rest having been winterkilled. Among the survivors were a few which seemed to be of a different type, with large, coarse-growing straw and very large, composite heads which were different in appearance and of darker color than the ordinary ones. These particular plants were used by Prof. Buffum as the basis for an improved strain of winter emmer. He reports that in the three seasons since 1908 none of it has winterkilled, so far as observed, and that it has come true to the type selected. In the fall of 1908 he planted about four-fifths of an acre of bench land to this strain of emmer. The seed was dropped by hand in rows 2½ feet apart, with only a single seed in a place so far as possible. In 1909 this four-fifths acre (fig. 6)

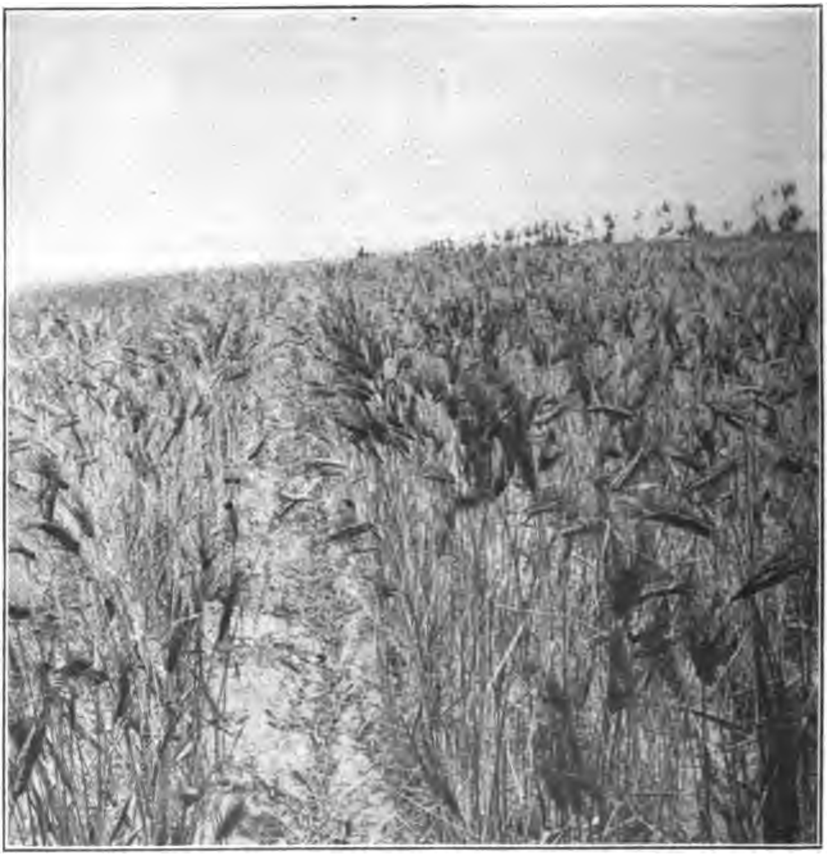

Fig. 6.—Increase plat of Improved Winter emmer, 1909. Rows 2½ feet apart and plants about 4 inches apart in the row; yield at the rate of 42½ bushels per acre. Photographed at Worland, Wyo.

yielded 34 bushels of seed weighing between 34 and 36 pounds per bushel.

In the fall of 1909 a 10-acre field was sown to this seed. Earlier in the season the field had been sown to Canada peas, but a lack of water and the hot summer prevented the peas from making any profitable growth. A volunteer crop of spring barley and spelt came up and these and the few peas were cut for hay. The ground was then plowed, irrigated, and, in September, sown to the emmer, which made a small growth before freezing weather commenced. The rate of seeding was from 30 to 34 pounds per acre. In the spring of 1910 the plants on this field looked thin and scattered, but apparently none had been winterkilled. During the third irrigation of the field a break in the canal left the crop without further water for 26 days. The field yielded 691 bushels, or at the rate of 69.1 bushels per acre. (Fig. 7.) The crop of 1911 was also good, but the actual yields are not yet known.

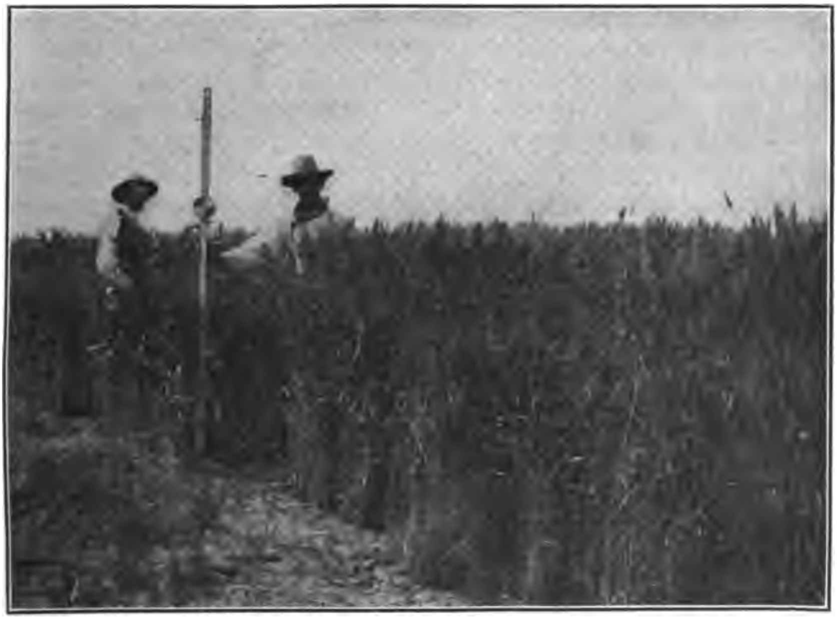

Fig. 7.—Side view of a 10-acre increase field of Improved Winter emmer. The estimated yield of this portion of field was 140 or 150 bushels per acre. The actual yield of the 10 acres was 691 bushels. Photographed at Worland, Wyo.

The most important feature of Prof. Buffum's report is that with reference to winterkilling. As stated, in the spring of 1908 it was found that only 72 plants had survived the winter from the sowing of 2 quarts of the original seed. This natural selection has apparently resulted in the production of a much hardier strain. In the three following crops of 1909 to 1911 little or no winterkilling has occurred.

This strain of winter emmer, therefore, after a trial of three years without winterkilling probably completely establishes winter emmer as a winter-hardy crop in intermountain districts as far north as northern Wyoming, especially as the winter of 1909–10 was unusually severe. As also stated in the report, the 72 plants surviving in the spring of 1908 showed considerable variation in the form of head, some of them being composite. Only about a dozen plants having large composite heads were selected and planted that fall, and from these plants have resulted all the crops since grown. Because of this selection of a comparatively pure strain unusually hardy it is now called the improved winter emmer. From the dozen selected plants of the 1908 crop were produced 34 bushels in 1909 and 710 bushels in 1910, while the present crop (1911), at this date unthrashed, is estimated at about 20,000 bushels. This is an unusual record and somewhat similar to that achieved by David Jones with the Swedish Select oat.[1] It will now be important to test this strain in the Northern States east of the Rocky Mountains, and the results of such tests will be awaited with much interest.

VALUE OF WINTER EMMER AS A FIELD CROP.

Winter emmer will be found of much value in a field-cropping system in several ways. Since it is used for stock feeding in the same way as oats or barley, it will be of much use in localities where those crops do not give good results. In a number of the Central, Southern, and Eastern States, where oats do not do so well as in the North and where winter oats would not be hardy, there is considerable demand for a winter cereal to be used as stock feed. This crop should exactly fill that demand. It will ripen earlier than oats, yield better, and may furnish a considerable quantity of fall and winter pasturage when the ground is in condition for turning stock into the field with safety. It will withstand extremes of climate much better than any other cereal. For a large part of the United States, therefore, it may be considered a general-purpose crop so far as climate is concerned, but it will not withstand the winter in the Northern States east of the Rocky Mountains.

In the Rocky Mountain and Pacific coast region winter emmer will be particularly valuable as a stock feed in dry farming, for the reason that often the drought is too great for ordinary crops of oats and barley, but not sufficient to prevent the production of a fair crop of emmer. It can, therefore, be used as a parallel crop to winter wheat, the emmer being grown for stock feeding and the winter wheat for sale. The best results with winter emmer so far have been obtained in intermountain districts.

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[1] Carleton, M. A. Ten Years' Experience with the Swedish Select Oat. Bulletin 182, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, pp. 29–30.

USES OF WINTER EMMER.

In Germany, Russia, and other southeastern countries of Europe emmer is often used as human food. In Russia such use is chiefly in the form of breakfast foods. In other countries it is used to a considerable extent in bread making. In the United States emmer is not yet used for human food, but it may be so used before many years, as it is known to furnish an excellent breakfast food.

A number of experiments in the use of emmer for feeding to stock have been made already at several of the experiment stations with various results. Emmer has usually been found, however, a fairly good food, though in some cases barley or oats appear to be better. To decide accurately between emmer and the other crops, however, one must consider the greater possibility of obtaining a crop of emmer in the drier districts. Several bulletins on the feeding value of emmer have been published by the South Dakota Agricultural Experiment Station, the first results having been published in 1901. In these first experiments it was found that emmer was worth about two-thirds as much per bushel as barley for feeding to fattening lambs as a single-grain ration and that about twice the profit can be realized from fattening sheep on barley as can be obtained from feeding upon emmer under the same conditions, where the expense of caring for the sheep is disregarded.[1] A further conclusion is that emmer is not a proper food for fattening lambs as a single-grain ration.

In 1906 further results were published from this station[2] on the use of proso, or Russian millet, and emmer for feeding calves in comparison with corn and oats. In this instance emmer produced good results as compared with corn. The lot of calves fattened on emmer did not produce as much average daily gain as the lot fattened on corn, but the difference was not great, and during the pasturing period the lot fed on emmer gained 112 pounds more than the lot fed on corn. It required only 5.16 pounds of emmer during this pasturing period to produce a pound of gain, compared with 7.03 pounds of corn. An important feature is that the lot fed on emmer did not consume as much hay per pound of gain as did other lots, showing that the chaff of emmer is a good substitute for hay.

In Bulletins Nos. 81 and 86 of the South Dakota station, results were published, showing that it requires more pounds of emmer to produce a pound of gain, either in butter fat (in feeding to dairy cattle) or in flesh (in fattening range lambs).

In another publication from the South Dakota station in 1907 it was found, among other things, that a pound of corn is equal to 1¼ pounds of emmer for steer feeding and that where the corn and emmer were mixed half and half by weight the relation was about the same, with a small gain in favor of the mixture.[1] It was also found to be a detriment to feed ground emmer instead of the whole kernel, the palatability of the food appearing to be thus decreased.

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[1] Chilcott, E. C., and Thornber, W. T. Speltz vs. Barley—A Comparison of the Food Value of Speltz and Barley as a Single-Grain Ration for Fattening Sheep. Bulletin 71, South Dakota Agricultural Experiment Station, 1901, p. 88.

[2] Wilson, James W., and Skinner, H. G. Speltz and Millet for the Production of Baby Beef. Bulletin 97, South Dakota Agricultural Experiment Station, 1906.

In a publication from the Wyoming station in 1909[2] on emmer feeding, using for feeds emmer, barley, and alfalfa, it was found among other things that 27 per cent less alfalfa and 28 per cent less grain were required in a feed for lambs when barley replaced emmer in a ration.

The Colorado station gives an account[3] of interesting trials showing good results from feeding emmer. Of five lots of lambs fed different combinations of food, a lot fed with emmer and alfalfa gave the most profit. The cost per pound of gain of feeding each of the first lots and the resulting profit in each case were as follows:

TABLE II.—*Cost and profit in feeding lambs with different feeds.*

Lot.	Feed.	Cost.	Profit.
		Cents.	
1	Corn and alfalfa	5.25	$1.65
2	Emmer and alfalfa	4.28	3.04
3	Barley and alfalfa	4.95	2.02
4	Wheat, barley, and alfalfa	4.68	2.30
5	Wheat, emmer, and alfalfa	5.93	.52

It is seen in feeding with the various combinations of cereals, some results are favorable and some are unfavorable to the use of emmer. As before remarked, the adaptability of emmer in the drier districts must be taken into consideration together with the greater quantity of grain per acre that may be produced in these districts by growing this crop.

PRODUCTION OF EMMER IN POUNDS OF GRAIN PER ACRE AS COMPARED WITH OTHER CEREALS.

It is important to know, if possible, the amount of grain per acre by weight that emmer will furnish compared with other cereals that may be used in stock feeding in order to determine which crop it is most profitable to grow for that purpose when quality is also taken into consideration. The North Dakota station[4] presents a tabular statement of yields for eight years in pounds per acre of emmer, barley, oats, common wheat, and durum wheat, here reproduced as follows:

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[1] Wilson, James W., and Skinner, H. G. Bulletins of the South Dakota Agricultural Experiment Station: No. 81, Feeding Dairy Cows, II, 1903, pp. 27-40; No. 86, Fattening Range Lambs, 1904, pp. 1-16; No. 100, The Feeding Value of Speltz in Beef and Pork Production, 1907, pp. 119-128.

[2] Faville, A. D. Lamb Feeding for 1908-9. Bulletin 81, Wyoming Agricultural Experiment Station, 1909, p. 8.

[3] Buffum, B. C., and Griffith, C. J. Lamb Feeding Experiments. Bulletin 75, Colorado Experiment Station, 1902, pp. 21-27.

[4] Shepperd, J. H., and Churchill, O. O. Cereal Crop Experiments. Bulletin 75, North Dakota Agricultural Experiment Station, 1907, p. 312.

TABLE III.—*Comparative yields in pounds per acre of emmer, barley, oats, and wheat for eight years at Fargo, N. Dak.*

Kind of grain.	1898	1899	1900	1901	1902	1903	1904	1906	Average.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Emmer	2,338	2,291	980	2,518	2,469	2,101	1,976	890	1,945
Barley	2,336	2,360	844	1,946	2,780	2,079	1,704	840	1,877
Oats	2,400	2,436	1,058	1,933	1,988	2,378	2,054	1,610	1,969
Wheat	2,212	1,552	1,379	1,719	1,590	2,694	984	1,560	1,711
Durum wheat	....	1,948	1,167	1,997	1,943	2,833	1,410	1,500	1,835

It is seen that in acre yield emmer exceeded all other cereals except oats, which exceeded emmer only slightly.

At the Dickinson, N. Dak., substation[1] the average acre yield in pounds of four cereals for the years 1907–1909 was as follows: Emmer, 1,893; barley, 2,011; oats, 2,321; and wheat, 1,871. Here emmer yielded more than wheat but considerably less than either oats or barley, oats standing highest of all.

The fact should be considered that these results at both stations were obtained while using spring emmer in the comparison. As in all other cases where winter grains are compared with spring grains, winter emmer would no doubt give much better yields.

CHEMICAL ANALYSES.

Below are given a few analyses of emmer, of the chaff and the kernel separately, and also of the two ground together.

TABLE IV.—*Analyses of emmer.*

Determination.	Kernels and chaff.	Kernels alone.	Chaff alone.	Straw.
1. By Prof. James H. Shepard, of the South Dakota Agricultural Experiment Station:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	10.17	10.86	8.12	....
Ash	2.95	1.46	7.45	....
Ether extract	2.46	2.76	1.48	....
Crude fiber	11.45	2.26	39.02	....
Crude protein	11.57	14.64	2.39	....
Nitrogen-free extract	61.39	68.02	41.54	....
Total nitrogen	1.84	2.34	.38	....
Albuminoid nitrogen	1.42	1.79	.30	....
2. By Prof. E. F. Ladd, of the North Dakota Agricultural Experiment Station: *				
Water	8.88	10.03	4.62	....
Ash	4.33	1.84	13.58	....
Fat	2.55	2.80	1.64	....
Protein	9.81	11.69	2.81	....
Crude fiber	10.09	2.94	36.68	....
Carbohydrates	64.34	70.70	40.67	....

* Shepperd, J. H., and Ten Eyck, A. M. Crop Report for 1898. Variety Tests; Thickness and Depth of Planting Grain, Forage, and Root Crops. Bulletin 39, North Dakota Agricultural Experiment Station, 1899, p. 436.

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[1] Waldron, L. R. Second Annual Report of the Dickinson Subexperiment Station, for the year 1909, p. 34.

TABLE IV.—*Analyses of emmer*—Continued.

Determination.	Kernels and chaff.	Kernels alone.	Chaff alone.	Straw.
3. By Dr. H. W. Wiley, Chief, Bureau of Chemistry, United States Department of Agriculture (samples furnished by the Bureau of Plant Industry):				
(1) 2789—*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	9.05	10.88	8.89	....
Ash	3.33	1.53	7.77	....
Fat	2.10	2.13	.60	....
Albuminoids	13.69	14.88	4.50	....
Amido bodies	....	2.10	.38	....
Total nitrogenous bodies	13.69	16.98	4.88	....
Moist gluten	....	41.02	....	....
Dry gluten	....	14.77	....	....
Crude fiber	8.37	1.69	30.70	....
Pentosans, lignins, organic acid, etc	20.43	18.56	39.66	....
Starch	43.03	48.23	7.50	....
(2) 2959—*				
Water	8.57	10.06	6.77	....
Ash	2.83	1.25	7.16	....
Fat	1.50	2.11	.71	....
Albuminoids	13.00	14.88	3.50	....
Amido bodies	.43	1.36	.21	....
Total nitrogenous bodies	13.43	16.24	3.71	....
Moist gluten	....	37.85	....	....
Dry gluten	....	13.26	....	....
Crude fiber	7.83	1.73	31.52	....
Pentosans, lignins, organic acid, etc	18.69	16.47	41.32	....
Starch	47.15	52.14	8.81	....
4. Kernels and chaff carefully separated by hand, weighed and analyzed—kernel, 72.2 per cent; chaff, 27.8 per cent: †	*Spikelets.*‡			
Water, air dry	6.95	8.00	4.22	4.61
Ash—				
Air dry	4.85	2.15	11.85	9.06
Water free	5.21	2.34	12.37	9.50
Ether extract—				
Air dry	1.59	1.80	1.05	1.37
Water free	1.71	1.96	1.10	1.44
Crude fiber—				
Air dry	12.32	1.86	39.50	42.64
Water free	13.24	2.02	41.24	44.70
Crude protein—				
Air dry	10.04	12.68	3.16	2.14
Water free	10.79	13.78	3.30	2.24
Nitrogen-free extract—				
Air dry	64.25	73.51	40.22	40.18
Water free	69.05	79.90	41.99	42.12

* Numbers used by the Office of Foreign Seed and Plant Introduction.

† Unpublished analyses reported March, 1911, by Prof. Henry G. Knight, University of Wyoming, received through Prof. B. C. Buffum.

‡ Calculated from the analyses of kernels and chaff.

The first three analyses are of spring emmer. The fourth one, by Prof. Knight, is an analysis of the improved winter emmer, developed by Prof. Buffum, which has already been discussed.

One interesting feature of the above analyses is the considerable quantity of crude protein found in emmer. It would be considered a rather "heavy" or concentrated food if fed without the hulls. However, the presence of the hull, or chaff, counteracts this heaviness and appears to make it all the better, the hull furnishing the quantity of roughage necessary to make it a complete food.

Dr. J. S. Chamberlain, formerly of the Office of Grain Investigations, in 1909 published a bulletin on the feeding value of cereals, and in the investigations therein reported emmer and einkorn were included with the other cereals.[1] Table V, taken from page 43 of that bulletin, gives the pounds of digestible nutrients per 100 pounds of dry matter in emmer, einkorn, and oats.

TABLE V.—*Digestible nutrients in oats, emmer, and einkorn.*

[Pounds per hundred pounds of dry matter.]

Cereals.	Protein.	Fat.	Crude fiber.	Carbohydrate.	Production value—gain in flesh.	Nutritive ratio.
Oats	10.73	3.59	3.17	51.04	17.86	5.8
Emmer	9.96	1.36	4.98	52.06	17.20	6.0
Einkorn	11.00	1.55	5.96	48.04	16.81	5.2

The author comments as follows:

> With the less common grains, emmer and einkorn, it is seen that while the protein in emmer is somewhat lower, the production value and nutritive ratio are nearly the same as that of oats. Einkorn, owing to higher crude fiber, falls below the other two in production value and nutritive ratio. It is plain, however, that both of these grains belong in the oat class rather than in the wheat class. * * * The hulled emmer would, if fed as such, be as much like wheat, however, as it is like oats when fed with the hulls. * * * The average protein content of emmer is nearly 1 per cent lower than that of oats, yet there are 108 samples out of 242 of United States oats which have a protein content less than the average of the emmer, and 7 samples of emmer out of 25 have a higher protein content than the average of the oats. * * * For feeding purposes, then, the less common cereals, emmer and einkorn, when used with the hulls may be considered as belonging with oats in the group of high protein, muscle, or energy-producing foods and nearly equal to the latter in intrinsic food value.

CULTIVATION OF WINTER EMMER.

The preparation of the land, seeding, and subsequent management of the winter-emmer crop are practically the same as that required for rye and winter wheat and have been discussed in different publications of the Department of Agriculture. As the crop is well adapted as a winter cereal to intermountain districts of the West where dry farming is practiced, the first requisite, of course, is to have the land thoroughly prepared for the conservation of moisture. It may be sown either on summer fallow or follow a cultivated crop. If following an uncultivated crop, the ground should be plowed rather deeply as soon as possible after the latter crop is removed and thereafter often surface cultivated, particularly after rains, to conserve as much moisture as possible for the emmer. Seeding should be done only with the drill. It should be sown about the same time as winter wheat, the date ranging from about August 20 to October 1. In the drier districts the rate of seeding should be about the same as for barley—that is, from 4 to 6 pecks per acre.

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[1] Chamberlain, Joseph S. The Feeding Value of Cereals, as Calculated from Chemical Analyses. Bulletin 120, Bureau of Chemistry, U. S. Dept. of Agriculture, 1909, pp. 30–32, 43–45, 47, 55–56.

In the Eastern and Southern States, where the rainfall is greater, it is nevertheless often rather dry near seeding time. Much the same treatment of the soil should, therefore, be practiced as in the Western States, except that the need of conserving moisture will not usually be so great. Also, in the humid areas it is possible to follow a cultivated crop with emmer and it is never necessary to sow it on summer fallow. The crop may take the place of winter wheat or winter barley in systems of rotation.

USE OF WINTER EMMER IN WHEAT BREEDING.

Emmer is really a subspecies of wheat, and in actual experience it has been found that it can be readily crossed artificially with the common wheats. It is probably true that many natural crosses occur where emmer is sown near ordinary wheat, which would account for a number of cases of unusual mixtures that have been found in wheat fields near where emmer has been grown. Varieties of spring emmer have already been used by this department and by experiment stations in producing hybrids for the purpose of adding rust resistance to ordinary wheats. The use of winter emmer would have an added value for this purpose in winter-wheat districts, since emmer itself is to a considerable degree winter hardy. The winter emmer appears also to be even more resistant to rust than most of the spring varieties.

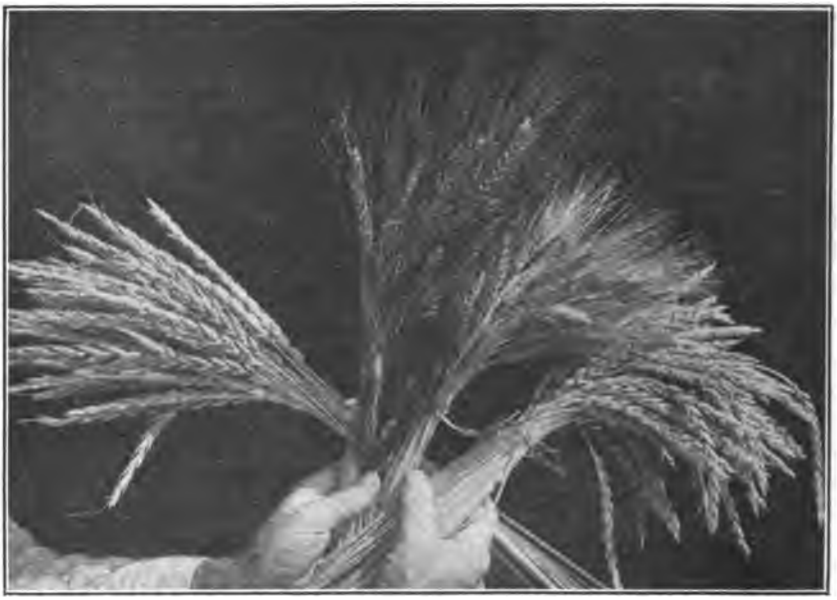

FIG. 8.—Two bundles of bearded grain, showing the black-glumed and white-glumed types of the sporting emmer, and two bundles of beardless grain, showing two hybrids which came true to the selection in the second generation. Photographed at Worland, Wyo.

There is a tendency in the winter emmer, when placed under unusually stimulating conditions, to produce compound or branched heads. This is particularly likely to occur when it is transported from a certain locality to another where the soil conditions and climate are particularly favorable. This tendency to produce compound heads appears to be characteristic of all winter-emmer varieties. There are red-chaff winter emmers and white winter emmers, as well as the black variety. Each of these has a corresponding compound form, such as the Red Winter compound emmer, the Black Winter compound emmer, etc. Only one other group of wheats, the poulards, is known to have this peculiarity of compounding its heads. This tendency to produce compound heads and the probability that all emmers often produce natural crosses with wheat probably account largely for the numerous sports obtained in connection with the development of the improved winter emmer already discussed. (Fig. 8.)

It is seen, therefore, that there is considerable opportunity of producing valuable results in wheat breeding by the use of the many varieties of emmer, if we include both the spring and the winter forms, and no doubt in the future much of the actual improvement of the wheats of this country will be accomplished in that way.

SUMMARY.

Emmer has been known as a profitable crop in parts of the United States for 15 to 20 years. Both winter and spring varieties are grown, but the spring varieties have been most commonly planted.

There is an increasingly strong demand for a drought-resistant winter feeding crop in many parts of the country. This paper discusses the superior value of winter varieties for certain conditions.

Emmer is commonly but incorrectly called spelt or "speltz." True spelt is a distinct crop. Emmer has stouter, compact, and usually bearded spikes which on breaking up in thrashing leave a short, pointed pedicel attached to each spikelet. Spelt spikes are more slender and loose, both bearded and beardless, and, in breaking up, the pedicel usually does not remain attached to the base of the spikelet.

All varieties of emmer are considerably resistant to drought and certain varieties are very resistant to rust. They are also considerably resistant to the effects of wet weather in humid climates, though best adapted to rather dry regions with hot summers.

Emmers are cultivated throughout southern Europe and to some extent in east-central Africa. They are very largely grown in Russia.

Black Winter emmer was first introduced from France by the Department of Agriculture in 1904, and the seed has been increased and distributed as rapidly as possible since that date.

It has been tested on many of the Departmental experiment farms with good results. A 5-year test at McPherson, Kans., gave an average acre yield of 45.5 bushels, the highest yield obtained being 77 bushels in 1908. Five crops grown in the Panhandle of Texas averaged about 35 bushels per acre.

Many cooperating farmers in the Western States report yields ranging from 25 to 60 bushels per acre. A seed-breeding farm in Wyoming has been selecting a strain of this Black Winter emmer with special reference to winter resistance. In 1909 this variety yielded at the rate of 42.5 bushels per acre and in 1910 a 10-acre field yielded at the rate of 69.1 bushels per acre. Both crops were grown under irrigation.

Emmer withstands extremes of climate much better than any other cereal and is well adapted for use as a general-purpose crop.

Winter emmer is likely to prove of value as a feeding crop in a number of the Central, Southern, and Eastern States where oats are not profitably grown. It will ripen earlier and yield better than oats and may furnish fall and winter pasturage also.

In the Rocky Mountain and Pacific Coast States winter emmer will be particularly valuable as a stock feed under dry farming. The best results, so far, have been obtained in intermountain districts. It will probably not be winter resistant in the Northern States east of the Rocky Mountains.

In Europe emmer is often used as human food, in Russia chiefly in the form of a breakfast food, and in the other countries to a considerable extent in bread making.

In the United States it has been and is likely to be most used for stock feeding. In a considerable number of feeding tests conducted at different stations emmer has been found nearly, if not quite, equal to barley and oats for sheep and cattle.

In deciding the value of emmer not only its comparative feeding value but its comparative productiveness and certainty in western dry-farmed areas must be taken into account.

Since the emmer kernel does not become separated from the chaff in thrashing, emmer is more comparable to oats and barley than to wheat as a feeding grain.

The preparation of the land, the seeding, and subsequent management of the winter emmer crop are practically the same as required for rye and winter wheat.

Emmer is really a subspecies of wheat and can be readily crossed with wheat by artificial means. It is being used in this way for the purpose of adding rust resistance to wheat hybrids.

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Issued October 28, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 467.

THE CONTROL OF THE CHESTNUT BARK DISEASE.

BY

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AND

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WASHINGTON:
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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 14, 1911.

Sir: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript entitled "The Control of the Chestnut Bark Disease," by Dr. Haven Metcalf, Pathologist in Charge, and Prof. J. Franklin Collins, Forest Pathologist, of the Office of Investigations in Forest Pathology. The writers describe their method of restricting the spread of this dangerous disease by destroying advance infections, a method which is already being applied on a large scale by the State of Pennsylvania. It is hoped to perfect plans whereby through general cooperation the disease may be kept within the territory where infection is already general and the largest and best chestnut forests of the country, especially those of the south Appalachians, be kept permanently free from the disease.

The experimental data upon which the recommendations contained in this publication are based will be published in full in a forthcoming bulletin of the Bureau of Plant Industry.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE CONTROL OF THE CHESTNUT BARK DISEASE.

THE DISEASE.

HISTORY AND DISTRIBUTION.

The chestnut bark disease was first recognized as a serious disease in the vicinity of New York City in 1904, and the first publication regarding it appeared in 1906. There is reliable evidence, however, that it was present on Long Island at least as early as 1893. Its origin is unknown, but there is some evidence that it was imported from the Orient with the Japanese chestnut. This view is not, however, held by all investigators. But whatever may have been its time or place of origin, it is certain that it has now spread into at least 10 States, as is shown by the accompanying map (fig. 1). In the vicinity of New York City and through adjacent counties it has killed practically all chestnut trees. Throughout a much larger neighboring area, as shown in figure 1, practically all chestnut trees are infected. Outside of this area, throughout the country from the northern border of Massachusetts and from Saratoga County, N. Y., to the western border of Pennsylvania and the southern border of Virginia, scattering areas of infection are known to occur and may be expected at any point.

So far as is now known, the bark disease is limited to the true chestnuts—that is, to the members of the genus Castanea. The American chestnut, the chinquapin, and the cultivated varieties of the European chestnut are all readily subject to the disease. Only the Japanese and perhaps other east Asian varieties appear to have resistance. In spite of popular reports to the contrary, it can be quite positively stated that the bark disease is not now known to occur on living oaks, horse-chestnuts, beeches, hickories, or the golden-leaf chinquapin (*Castanopsis chrysophylla*) of the Pacific coast.

FINANCIAL LOSSES.

The bark disease appears ultimately to exterminate the chestnut trees in any locality which it infests. A survey of Forest Park (Brooklyn) showed " that 16,695 chestnut trees were killed in the 350 acres of woodland in this park alone. Of this number, about 9,000 were between 8 and 12 inches in diameter, and the remaining 7,000 or more were of larger size." Three years ago the financial loss from this disease " in and about New York City " was estimated at " between five and ten million dollars."

The writers regard $25,000,000 as a conservative estimate of the financial loss from this disease up to 1911. In many localities the greatest damage has been among chestnuts grown for ornamental purposes, which have a value greatly in excess of their value as lumber.

Depression in the value of real estate, especially suburban or near-suburban, owing to the death of the chestnut trees, must be taken into account in an estimate of this kind, as well as the loss of the trees themselves.

CAUSE AND SYMPTOMS.

The chestnut bark disease is caused by a fungus parasite known under the technical name of *Diaporthe parasitica* Murrill. When any of the microscopic spores (reproductive cells) of this fungus gain entrance into any part of the trunk or limbs of a chestnut tree they give rise to a spreading "sore" or lesion, which soon girdles the tree. If the part attacked happens to be the trunk, the whole tree in consequence is killed, perhaps in a single season. If the smaller branches are attacked, only those branches are killed, or only those portions of branches beyond the point of attack, and the remainder of the tree may survive for several years (fig. 2).

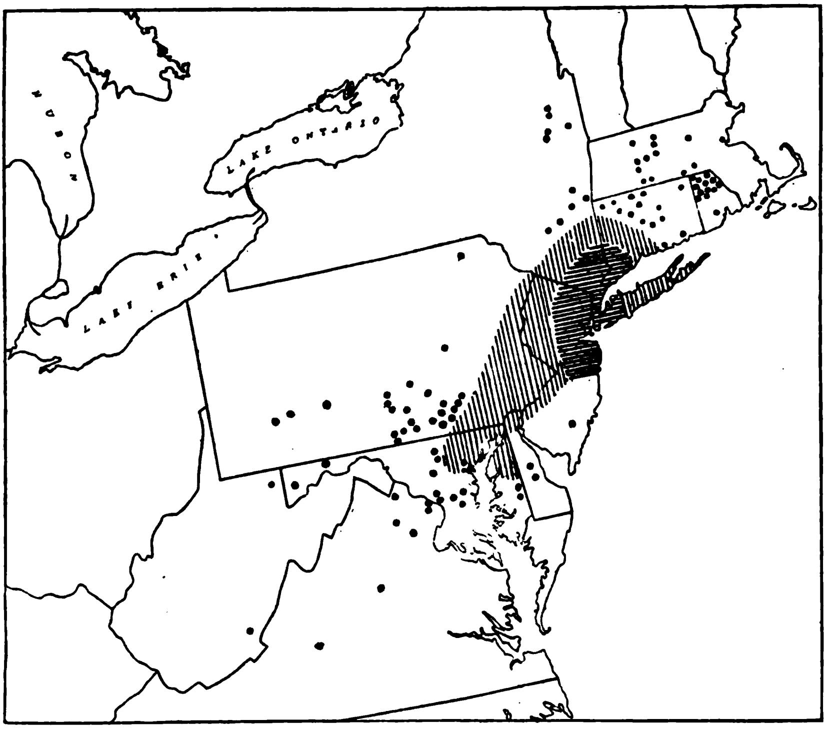

FIG. 1.—Map of the northeastern part of the United States, showing the distribution of the chestnut bark disease. The horizontally lined part shows the approximate area wherein the majority of chestnut trees are already dead from the bark disease. The part marked by vertical lines shows the approximate area wherein infection is already complete. The round dots show the location of advance infections of the disease. Many of these have already been eradicated. The map has been compiled from both observations and correspondence. The writers are under especial obligations to Dr. Perley Spaulding, Prof. A. H. Graves, Mr. I. C. Williams, Mr. W. H. Rankin, Mr. J. F. O'Byrne, Mr. F. W. Besley, Dr. Ernest S. Reynolds, and Mr. H. G. MacMillan, for data along this line. According to Dr. G. P. Clinton (Connecticut Agricultural Experiment Station, Report of the Botanist, 1909 and 1910) there are many more points of infection in Connecticut than are shown on this map.

Some of the symptoms are quite prominent. Limbs with smooth bark attacked by the fungus soon show dead, somewhat discolored, sunken areas (occasionally with a raised margin), which continue to enlarge and soon become covered more or less thickly with yellow, orange, or reddish-brown spots about the size of a pinhead. These spots are the pustules of the fruiting fungus. In damp weather or in damp situations, masses of summer spores are extruded in the form of long, irregularly twisted strings or "horns," which are at first bright yellow to greenish yellow or even buff, becoming darker with age (fig. 3). If the lesion is on the trunk or a large limb with very thick bark there is no obvious change in the appearance of the

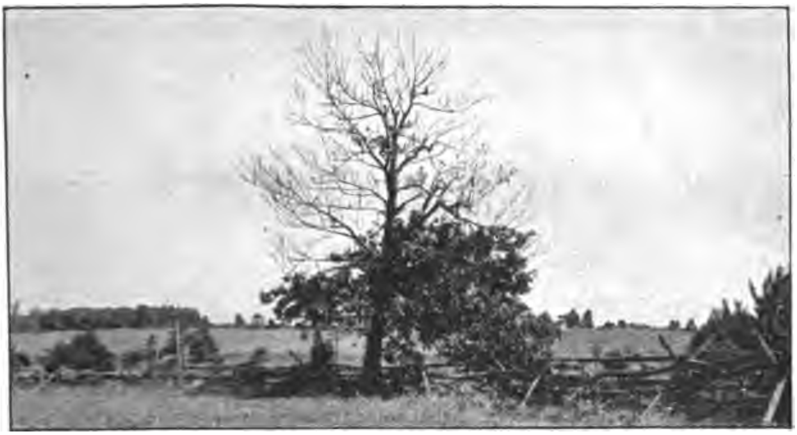

FIG. 2.—Large chestnut tree partly killed by the bark disease. Note the sprouts with leaves near the top, the dwarfed leaves on the lower right-hand limb, and the healthy lower branches with leaves.

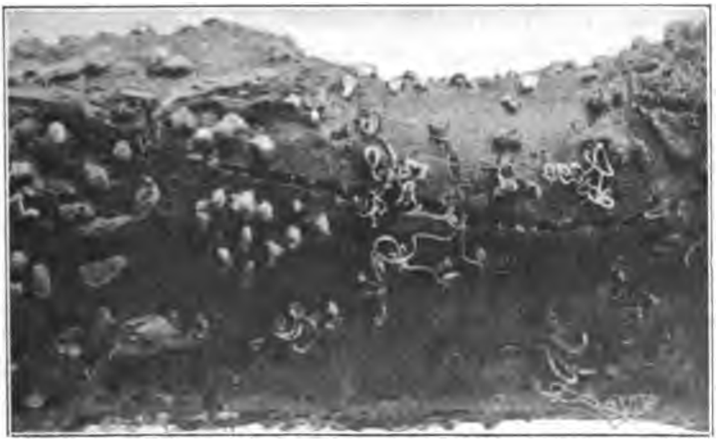

FIG. 3.—Diseased chestnut bark showing pustules and form of discharge of summer spores in damp weather. (Magnified 3 diameters.)

bark itself, but the pustules show in the cracks and the bark often sounds hollow when tapped. After smooth-barked limbs or trunks are girdled the fungus continues to grow extensively through the bark, sometimes covering the entire surface with reddish-brown pustules (fig. 4). These pustules produce mostly winter spores (ascospores), although occasionally the long strings of summer spores (fig. 3) are also produced, even on bark that has been dead at least a year.

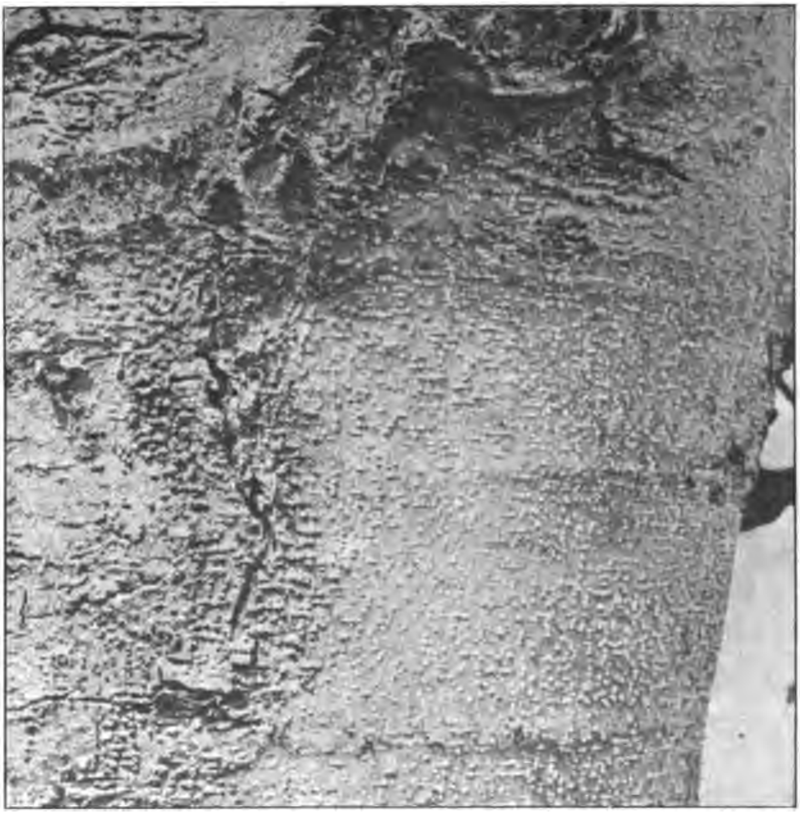

FIG. 4.—Dead chestnut bark showing pustules of the parasitic fungus bearing winter spores.

After a branch or trunk is girdled, the leaves change color and sooner or later wither. Such branches have a very characteristic appearance and can hardly be mistaken for anything else, except in certain localities where the work of twig-girdling insects may produce a similar appearance in the spring. In case the girdling by the fungus is completed late in the season, the leaves of the following spring assume a yellowish or pale appearance and do not develop to their full size (fig. 2). If the girdling is completed between spring and midsummer the leaves may attain their full size and then turn a somewhat characteristic reddish-brown color, which can easily be detected at a long distance. Later this leaf coloration changes to a more brownish tinge and the leaves are commonly persistent for a considerable time. The chestnut fruits (burs) on a spring-girdled branch may or may not attain full size, according to whether the girdling by the disease was completed late or early in the spring. These burs commonly persist on the tree during the following winter, thus producing the only symptom which is at all conspicuous during the leafless season. The great damage which the disease has done in the late summer thus becomes most evident at the beginning of the next season, and that done in the spring becomes evident later in the same season, giving rise to the false but common idea that the fungus does its work at the time of year that the leaves change color, when in reality the harm was done much earlier.

Perhaps the most easily seen as well as the longest persistent symptom of the bark disease is the prompt development of sprouts, or "suckers," on the trunk of the tree (fig. 2) and at its base, or somewhat less frequently on the smaller branches. Sprouts may appear below every girdling lesion on a tree, and there are usually many such lesions. These sprouts are usually very luxuriant and quick growing, but rarely survive the second or third year, as they in turn are killed by the fungus. The age of the oldest living sprout, as determined by the number of its annual rings, is an indication of the minimum age of that portion of the infection immediately above it. Sprouts are sometimes produced as a result of other injuries; for instance, trees girdled by borers may develop sprouts, but these are generally less rapid in growth and are distributed with greater uniformity over the trunk.

MEANS OF SPREAD AND ENTRANCE.

The disease is spread by the spores of the fungus, of which there are two kinds. As both kinds of spores appear to be sticky, there is no evidence that they are transmitted by wind except where they may be washed down into the dust and so blown about with the dust. The spores are spread easily through short distances by rain; particularly they are washed down from twig infections to the lower parts of the tree. There is strong evidence that the spores are spread extensively by birds, especially woodpeckers, and there is also excellent evidence that they are spread by insects and by various rodents, such as squirrels. The disease is carried bodily for considerable distances in tan bark and unbarked timber derived from diseased trees. One of the most prolific sources of general infection has been the transportation of diseased chestnut nursery stock from infected to uninfected localities.

When the spores have once been carried to a healthy tree, they may develop in any sort of hole in the bark which is reasonably moist. These may be wounds or mechanical injuries, but by far the most common place of infection is a tunnel made by a borer. Borers' tunnels are moist, even in dry weather, and in them the spore finds surroundings favorable to its development. In many parts of the country where the disease is prevalent there is very direct evidence that bark borers, and particularly the two-lined chestnut borer (*Agrilus bilineatus*), are directly associated in this way with 90 per cent or more of all cases of this disease. We are informed that the Bureau of Entomology will issue a circular on the insects associated with the chestnut bark disease.

The writers have no definite evidence, experimental or otherwise, to show that a tree with reduced vitality is more susceptible to infection, or that the disease spreads more rapidly in such a tree, than in a perfectly healthy and well-nourished tree of either seedling or coppice growth, provided that such reduced vitality does not result in or is not accompanied by bark injuries through which spores can gain entrance.

THE CONTROL OF THE DISEASE.

ELIMINATION AND QUARANTINE.

FUNDAMENTAL OBSERVATIONS AND EXPERIMENTS.

No method of immunizing individual trees against the bark disease is yet known, and no method of treating or curing them when once attacked is certain in its results. While this is unfortunate from the standpoint of the owner of orchard trees and large ornamental trees of great individual value, no method of dealing with single trees—surgery, medication, spraying, etc.—however successful in itself, would meet the demands of the present situation. It is not practicable at present to apply any individual method of treatment to forest trees; the individual tree is not worth it, and will not be for many years. Therefore, so far as the chestnut forests are concerned we do not need to regret particularly that no individual treatment has yet been discovered that is entirely effective.

Fortunately, however, there is a method of dealing with the situation which is applicable to the country as a whole and which, so far as tested, is practicable. Early in the course of the writers' investigations it became evident that the disease advances but slowly in a solid line, but instead spreads from isolated centers of infection, often many miles in advance of the main line of disease. That such is the case is evident from a glance at figure 1. It therefore seemed probable that if these advance infections could be located at a reasonably early stage, they could be eliminated at relatively little expense, thus preventing further spread from these points at least. Accordingly, the country within approximately 35 miles of Washington, D. C., was chosen in the fall of 1908 as preliminary territory in which to test this method of control. This section has since been gone over fairly thoroughly once a year. As will be seen by figure 1, 14 points of infection were located, and the infected trees destroyed. Most of this work was done by the senior writer. The largest infection was a group of nursery trees that had been imported from New Jersey; the smallest, a single lesion on a small branch of a large forest tree. In one case 11 forest trees in a group were infected, the original infection having been two trees, dating apparently from as early as 1907. Up to the present time (June, 1911) the disease has not reappeared at any point where eliminated and the country within a radius of approximately 35 miles from Washington is apparently free from the bark disease, although new infections must be looked for as long as the disease remains elsewhere unchecked. It is therefore believed that this method of attack will prove equally practicable in other localities, and if carried out on a large scale will result ultimately in the control of the bark disease.

LEGAL CONSIDERATIONS.

In carrying such a scheme of control into effect on a large scale, however, legal difficulties are at once encountered. The bark disease threatens the extinction of the chestnut throughout its range. As it has already been found in at least 10 States and the District of Columbia, it is essentially a national issue, but there is no law whereby the Federal Government can attempt to cope with the emergency. Each State must act on its own initiative and control the disease or let it go as its officers and legislative bodies see fit. Herein lies one of the most serious aspects of the matter; for if one State elects to undertake control of the disease it will be seriously handicapped if neighboring States do not. Any method of elimination, isolation, or quarantine in dealing with any disease of plants, domestic animals, or human beings necessitates general cooperation. It is not practicable to try to control the bark disease solely by the cooperation of individual owners of chestnut woodland, since a single indifferent or obstinate person can nullify the efforts of an entire community. The control of the chestnut bark disease must therefore be undertaken by the separate States under special legislation. Possibly in certain States the crop and woodland pest laws, which ordinarily apply only to nursery stock, may be broad enough to include this disease, but in most States the first thing to be done is to obtain the necessary legal authority and an appropriation for action along the following lines, as has already been done in Pennsylvania.

THE METHOD IN DETAIL.

Locating advance infections ("scouting").—The first thing to be done in each State is to determine the exact range of the disease in that State, and particularly to locate the advance points of infection. This is by far the most difficult feature of the entire program, because the work must be directed and in large measure carried out by experts; otherwise diseased trees will be left, and the results can not be depended upon. It is best intrusted to professional plant pathologists or at least to botanists familiar with fungi and the collecting of fungi, and even these must have some preliminary knowledge of this particular disease. The symptoms of the disease are too obscure and the means of locating it too intricate to make it possible for a person without a professional knowledge of plant diseases to deal successfully with the situation, no matter how well informed in agriculture or forestry or how experienced in the care of trees. It is suggested that in most States this part of the work would be best handled by the pathologists of the State agricultural experiment stations.

For assistants the pathologists having this work in charge should choose the best scientific observers obtainable, regardless of other considerations, but persons with some knowledge of plant pathology are to be preferred. College students trained in these lines are usually available, for the summer vacation at least, and make in many respects the most desirable "scouts" for this work. But all "scouts" must be carefully and individually trained by the expert in charge.

Attention should first be directed to the advance spots of infection already known to exist, and when found the diseased trees should be destroyed or marked for destruction. No difficulty will be experienced in locating infections 2 years old or more, but the greatest difficulty will be met in locating infections of the current year. Every tree in the immediate vicinity of older infected trees must be carefully gone over. Many dubious cases will be found, and from such trees samples of the suspected bark must be taken and sent to some laboratory for expert judgment. It is absolutely necessary to have arrangements with some laboratory whereby such work can be done and the results promptly reported.

After the spots already known to exist have been delimited and the trees destroyed or marked for destruction, the search should be continued. It is best next to clearly define the location of the main line of advance of the disease, back of which infection is general. Working away from this line as a base, a complete survey of the remainder of the State must be made, until it is reasonably certain that all spots have been located.

Scouting is best discontinued as soon as the leaves change color in the fall, since from October to April, inclusive, the symptoms are very obscure. Practically no sign of the disease is visible from a distance, except in those cases where the burs persist on the older trees. Even the pustules of the fungus become weathered, so that even a close examination of a tree may not yield visible results. But the destruction of trees already marked can continue through the winter.

Destroying advance infections.—Many of the advance infections will be found to consist of single trees or of less than half a dozen trees. These may perhaps be destroyed by the person who finds them, especially if remote from other infections; but the greater part of the work of elimination is best handled by other persons under separate direction. Undoubtedly this work can be best directed in each State by the State forestry officials.

The work of elimination should be done as soon as possible after the diseased trees are located, but may be done at whatever time of year is most convenient, since new infections will be detected by the scouting of the following year. The marked trees should be cut down. So far as is now known, the timber may be safely utilized in various ways, *provided it is barked.* The bark and brush should be piled over the stumps and, as soon as practicable, burned. If it is not practicable to have the fire over the stumps, the stumps should be barked to the ground; but in any case the bark and brush must be burned.

It will be readily seen that the task of locating the disease, and the subsequent one of eliminating it, call for very different talents. The "scouting" calls for carefully trained and absolutely accurate scientific observers working under the most highly specialized direction that can be obtained. The work of elimination calls not for scientific knowledge, but for executive ability, tact in dealing with owners and in otherwise administering the law, and a knowledge of forestry and of lumbering, market, and transportation conditions. In a word, the first is a task for pathologists, the second for foresters. Another advantage of thus dividing the work is that a certain rivalry will usually develop, resulting in more thorough work on both sides. It is, moreover, of the utmost importance to have as many different forces and interests as possible in any given State working toward the common end of controlling this disease.

Establishing the "immune zone."—After all advance spots of infection are eliminated, attention must be turned to the main line of advance—the edge of the area of general infection. Here the problem will present local differences. It may prove necessary in some States to destroy all chestnut trees, diseased or healthy, in a belt 10 to 20 miles wide, or possibly less. Advantage must be taken of natural barriers to infection, such as unforested areas or wooded areas without chestnuts. In this way an "immune zone" will be established, across which the disease can not easily be transmitted by merely local agents. Back of this line the chestnut trees may be abandoned to the disease. Every effort should be made, however, to have them cut down and the timber utilized as soon as possible, since they remain sources of distant infection as long as any spore-laden bark or diseased sprouts remain on them.

Quarantine.—Whether any restrictions are placed upon the movement of chestnut products from the area of complete infection to the protected territory will depend largely on local conditions and must be left to the judgment of State authorities. Barked timber can probably be moved with comparative safety. It will always be desirable to limit the movement of unbarked chestnut timber and firewood and of chestnut tan bark. An inspection of local conditions will readily determine whether the danger from these sources is sufficiently great to warrant the business inconvenience which would be caused by the quarantine of any or all chestnut products.

Program for the second year.—The work for the second year will consist mostly of reinspection of the advance spots where the bark disease has been eradicated the previous year and of general scouting to locate new spots. If the work of the first year has been thoroughly done and there has been time to complete the elimination of all spots located, only scattering infections may be expected. From this time on the persons in charge of scouting will have the bulk of work and responsibility.

THE EXAMPLE OF PENNSYLVANIA.

Pennsylvania enjoys the distinction of being the first and so far the only State to undertake in any way the control of the chestnut bark disease. In the summer of 1910 the Main Line Citizens' Association—an organization of citizens residing along the main line of the Pennsylvania Railroad near Philadelphia—appointed a committee of seven, under the chairmanship of Mr. Harold Peirce, to determine the status of the disease in that locality and to see what could be done toward controlling it. An extensive local survey of the disease was made under the direction of Mr. I. C. Williams, deputy State forest commissioner. The committee soon became convinced that the problem was of State and even national importance, and could only be solved by legislation and by the broadest cooperation. Accordingly they devoted their energies to securing the passage by the Pennsylvania Legislature of the following bill, which has now become a law. This law is almost unique in conservational legislation, and on account of its important bearing as precedent for similar laws in other States it is here reproduced in full.

AN ACT To provide efficient and practical means for the prevention, control, and eradication of a disease affecting chestnut trees, commonly called the chestnut-tree blight; providing for the destruction of trees so affected; creating a commission to carry out the purpose of this act; fixing penalties for violation of the provisions hereof; and making an appropriation therefor.

SECTION 1. *Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met; and it is hereby* *enacted by the authority of the same:* That a commission to consist of five members, to be appointed by the Governor for a period of three years from the date of the approval of this act, and to be called "The Commission for the Investigation and Control of the Chestnut-Tree Blight Disease in Pennsylvania," is hereby created, with power to ascertain, determine upon, and adopt the most efficient and practical means for the prevention, control, and eradication of a disease of the chestnut tree commonly known as the chestnut-tree blight disease; and for this purpose, in collaboration with the department of forestry, or otherwise, to conduct scientific investigations into the nature and causes of such disease and the means of preventing its introducton, continuance, and spread; to establish, regulate, maintain, and enforce quarantine against the introduction and spread of such disease; and, from time to time, to adopt and prescribe such regulations and methods of procedure as to it may seem necessary and proper for carrying into effect the purpose of this act, and exercising the powers and authority hereby conferred: *Provided*, That in the work of collaboration by the commission with the Department of Forestry said department may employ such means, and make detail of such men, and do such other things, as may seem to be necessary or expedient to accomplish the purpose of this act.

SEC. 2. Any member of the commission, or any of its duly authorized agents or employees, shall have the right, at any time, to enter upon any premises, wild lands, farms, fields, private grounds, and inclosures for the purpose of examining into the condition of any chestnut tree or trees thereon, and determining whether or not such trees, or any of them, have been attacked or infected by the chestnut-tree blight; and whenever this disease is found to exist, such commissioners, their duly authorized agents and employees, shall, in all practicable ways, cooperate with the owners of such trees in and for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; shall specifically advise and direct such owner how he shall proceed for the accomplishment of these ends; and shall leave with such owner, his agent, tenant, or other representative having charge of such trees, a notice, in writing, containing a description or plan specifically designating the trees so found to be diseased, and full and specific instructions for the treatment of such trees, or for the removal and destruction of designated parts thereof or of an entire tree or trees, as the case may require.

SEC. 3. If any owner of such trees, so found to be diseased by the said commission, its duly authorized agents or employees, shall neglect or refuse to cooperate in applying the necessary remedies for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; or shall neglect or refuse to comply with the requirements of the notice aforesaid, prescribing the treatment which shall be applied to such trees, so found to be diseased, within twenty days from the time such notice shall have been served, the said commission may at once proceed, through its duly authorized agents and employees, to do whatever may be found by it to be necessary and proper to accomplish the cure, control, or eradication of such disease and the prevention of its spread to other chestnut trees; and for this purpose, whenever it may be found necessary may remove, cut down, and destroy, or cause to be removed, cut down, or destroyed, any trees or parts of trees so found to be infected with such disease; and shall immediately thereafter duly certify to the owner of such trees, so treated or destroyed, or to his tenant, agent, or other representative in charge of such trees, the amount of the cost or expenses actually incurred by the commission in the treatment, removal, or destruction of such trees; and if the amount of such expense, so certified, shall not be paid by such owner of said trees, so treated, removed, or destroyed within sixty days after it shall have been so certified, the same may be recovered by the said commission, from such owner, by an action in the name of the Commonwealth, in the same manner as debts of like amount are now recoverable, and when recovered may be used by said commission in carrying out the purposes of this act.

Provided, however, That any owner or owners of trees, his or their tenants, agents, or representatives, who may be dissatisfied with any decision, order, or notice of any member of the commission, or any of its agents, or employees, directing or prescribing the treatment, removal, or destruction of trees belonging to or controlled by them, shall have the right within ten days from the time of the service upon them of such order or notice to appeal therefrom, in writing, to the commission, which shall thereupon, without avoidable delay, direct a re-examination of the premises or trees in question, by competent experts, who shall make report of their findings to the commision; which shall then fix a time and a place for a hearing before it, upon such appeal, and notify the person making appeal thereof. All further proceedings under such order or notice shall be suspended until the decision of the commission shall have been formally rendered.

SEC. 4. Whenever, in the judgment of the commission, it may be necessary to destroy chestnut trees not affected by the chestnut-tree blight, for the purpose of establishing a quarantine to prevent and control the spread of the disease, the owner of such trees shall be reimbursed for the loss of all the good and unaffected trees so destroyed; the amount to be paid therefor to be not greater than the stumpage prices of such trees, prevailing at the time in the locality where such trees grew; such value to be determined by the commission, by such method or procedure as it may adopt, and payment therefor to be made from the fund hereinafter specifically appropriated for the use ol the said commission in performing the duties required by this act. Should any owner of trees be dissatisfied with the amount awarded to pay for the destruction of such good and unaffected trees, said owner shall have all the remedies now existing, or which may hereafter be provided by law, for the protection of his interests.

SEC. 5. Any person who shall wilfully violate any of the provisions of this act, or any of the regulations of the commission intended to assist in carrying this act into effect, or shall wilfully resist or interfere with any agent or employee of the said commission in the performance of his duties in accordance with the regulations and orders of the commission, under the provisions hereof, shall be deemed guilty of misdemeanor, and shall upon conviction thereof be punished by a fine not exceeding one hundred dollars, or by imprisonment not exceeding one month, either or both, at the discretion of the court. The word "person," as used in this act, shall include not only individuals or natural persons, but as well artificial persons, existing only in contemplation of law, and shall be construed to mean partnerships, limited partnerships, joint-stock companies, and corporations, and the officers, agents, and employees of the same.

SEC. 6. The members of the commission shall serve without pay, but shall be reimbursed for all actual expense incurred by them in exercising the powers conferred upon them and performing the duties required by this act. The employees of the commission shall receive such compensation for their services as the commission shall determine will fairly compensate them for the work to be done. The commission shall be furnished with suitable rooms in the Capitol building at Harrisburg, or elsewhere, by the Superintendent of Public Grounds and Buildings. The sum of twenty-five thousand dollars is hereby specifically appropriated, to be immediately available upon the approval of this act, for the payment of such expense as may be incurred by the commission, for such scientific research and for office expenses, as in their judgment may be necessary to comply with the provisions hereof, said appropriation to be available until the first day of June, Anno Domini, one thousand nine hundred and thirteen; and the further sum of two hundred and fifty thousand dollars, or so much thereof as shall be necessary, is hereby specifically appropriated, to be available only upon the approval of the Governor, for the performance of all other duties herein required to be done; as, for quarantine, removal of diseased trees or other trees, conducting outside investigations and operations, and every other means of eradication and control, as to it may seem necessary in complying with the provisions hereof.

SEC. 7. All acts or parts of acts inconsistent herewith are hereby repealed.

The commission authorized by the bill has been appointed by the governor of Pennsylvania and consists of the following persons: Mr. Winthrop Sargent, chairman; Mr. Harold Peirce, secretary; Messrs. Samuel T. Bodine, George F. Craig, and Theodore N. Ely. Persons desiring information regarding the work on this disease in Pennsylvania should address the executive officer of the commission, Mr. Samuel B. Detweiler, 1112 Morris Building, Philadelphia, Pa.

INSPECTION OF DISEASED NURSERY STOCK.

As has been indicated, diseased chestnut nursery stock has in the past been a most important factor in the spread of the bark disease. On account of a well-grounded fear of this disease much less nursery stock is being moved now than formerly, but there is still enough to constitute a serious source of danger. It is therefore obvious that every State in which the chestnut grows, either naturally or under cultivation, should as speedily as possible pass a law putting the chestnut bark disease on the same footing as other pernicious diseases and insect pests, such as peach yellows and the San Jose scale, against which quarantine measures are taken. Many inspectors already have legal power to quarantine against the bark disease on chestnut nursery stock, and they should now take special care that no shipment, however small, escapes their rigid inspection.

The most serious practical difficulty in inspecting nursery stock for this as for other fungous diseases lies in the fact that practically all State inspectors are necessarily entomologists, and are not trained in recognizing the more obscure symptoms of fungous diseases. Nursery trees affected by the bark disease rarely show it prominently at the time when shipped; the threads of summer spores or the yellow or orange pustules are rarely present, and usually all the inspector can find is a small, slightly depressed, dark-colored area of dead bark, usually near the ground, which is easily overlooked or mistaken for some insignificant injury. Upon cutting into such a spot, the inner bark shows a most characteristic disorganized "punky" appearance, quite different from that of any other bark injury; but it is impossible to adequately describe this appearance without recourse to colored illustrations. Occasionally a yellowish-brown band, either girdling or partly girdling the young tree, may be seen; this is very characteristic, but is so prominent a symptom that it may be noticed at the nursery, and presumably trees so affected will not be shipped.

If infected trees are set out they develop the disease with its characteristic symptoms the following spring. But on account of their small size such trees are girdled and die before the end of the summer, often in two or three weeks. Meanwhile they are spreading the disease to neighboring orchard and forest trees. Orchardists and nurserymen purchasing chestnut trees are therefore warned to watch them closely during the first season, no matter how rigidly they may have been inspected.

INDIVIDUAL TREATMENT OF DISEASED TREES.

Where valuable ornamental, shade, or orchard chestnut trees become infected in one or more spots, the life and usefulness of such trees can be prolonged for several or for many years, depending largely upon the thoroughness with which the recommendations herein given for cutting out the diseased areas (lesions) are carried out. These recommendations are based upon the results of extensive experiments with hundreds of lesions during the past four years. These experiments were performed for the most part by the junior writer.

The essentials for the work are a gouge, a mallet, a pruning knife, a pot of coal tar, and a paint brush. In the case of a tall tree a ladder or rope, or both, may be necessary, but under no circumstances should tree climbers be used, as they cause wounds which are very favorable places for infection. Sometimes an ax, a saw, and a long-handled tree pruner are convenient auxiliary instruments, though practically all the cutting recommended can be done with a gouge with a cutting edge of 1 or 1½ inches. All cutting instruments should be kept very sharp, so that a clean and smooth cut may be made at all times.

By cutting with the gouge into a diseased area a characteristically discolored and mottled middle and inner bark is revealed. All of this diseased bark should be carefully cut out for at least an inch beyond the discolored area if the size of the branch will allow it. This bark should be collected in a bag or basket and burned. If the cutting is likely to result in the removal of the bark for much more than half the circumference of the branch or trunk, it will probably be better to cut off the entire limb or to cut down the tree, as the case may be, unless there is some special reason for attempting to save the limb or tree. The fungus usually, though not always, develops most vigorously in the inner bark next to the wood. When this is the case, not only all the diseased bark and an inch of healthy bark around it must be removed, but at least two or three annual layers of wood beneath the diseased bark must also be gouged out. Special care should be taken to avoid loosening the healthy bark at the edges of the cut-out areas. Except in the early spring this is not difficult after a little experience in manipulating the gouge and mallet, provided the gouge is kept sharp.

Small branches which have become infected should be cut off, the cut being made well back of the disease—at least 2 or 3 inches, if possible.

All cut-out areas and all the cut ends of stubs should be carefully and completely painted with coal tar. A good grade of paint has been recommended by some authorities as superior to tar, but it is more expensive. If the tar is very thick, the addition of a little creosote will improve it for antiseptic purposes as well as for ease in applying. If the first coat is thin, a second one of fairly thick tar should be applied within a few weeks or months. Other coats should be applied later whenever it becomes necessary.

The entire tree should be carefully examined for diseased spots and every one thoroughly cut out and treated in the way already described. In case of suspicious looking spots a portion of the outer bark can be cut out with the sharp gouge as a test. If this cut shows the characteristically discolored bark the spot can be considered as diseased and cut out accordingly; if the cut shows healthy bark, it need merely be treated with tar or paint, as other cuts are treated. In examining a tree for diseased spots it is always best to begin at the base of the trunk and work up, for if the trunk is girdled at the base it is useless to work anywhere on the tree.

When the spores of the fungus are present, especially in the form of threads, or "horns," they are readily washed down the branches and trunk by every rain, and are thus carried down to or toward the base of the tree. As a result the base of a tree, the crotches, and other places which afford easy lodgment for the spores are particularly subject to infection.

Although spraying with any of the standard fungicides appears to have no effect whatever in stopping the progress of the disease after it has once started in the inner or middle bark, there is little doubt that it is of use in preventing infection from spores washed down by rain from the upper part of a tree or from spores which have been transported from other trees. For this reason the spraying, after each rain, of the parts of a tree below a spore-bearing lesion is recommended, but only on an experimental basis. If no spore-bearing lesions occur on the tree, there is less apparent reason for spraying. The scattering of slaked lime about the base of a tree and the whitewashing of the trunk and larger limbs have shown apparently beneficial results in preventing infections and perhaps also depredations of borers.

A tree which is being treated for individual infections must be carefully watched and the diseased spots promptly cut out as they appear. For this purpose each tree should be examined very carefully two or three times at least during the growing season.

The Department of Agriculture asks the cooperation of all persons who have experimented with the disease in any way, and in return is ready to give specific advice, based upon extensive experience with the disease, as to the best methods of attempting its control or as to what are likely to be the most profitable systematic observations or experiments.

ADVICE TO CHESTNUT ORCHARDISTS.

In view of the uncertain future of the chestnut tree, the Department of Agriculture advises against planting chestnuts anywhere east of Ohio, at least until it is settled what efforts will be made by the individual States to control the bark disease. The only exception is that Japanese chestnuts may be grown if raised from imported seeds and not grafted on American stocks. If the seed is raised in America, the trees are more than likely to be hybrids with the American chestnut and to vary greatly in resistance to the bark disease. If grafted on American stocks, the stocks readily succumb to the disease, and so the whole tree is killed, no matter how resistant the scion may be. However, the nut of the true Japanese chestnut is of poor quality at best, and it is an open question whether it can ever be made a commercial success.

West of the natural range of the American chestnut, however, the situation is quite different. Obviously the western chestnut orchardist has before him a great opportunity. No matter how successful efforts to limit the bark disease in the East may be, the nut crop will be reduced for some years, and the business of growing fine orchard chestnuts in the East will be depressed for the same length of time. There is no apparent reason why, with rigid inspection, both of any purchased stock and of the orchards themselves, all chestnut orchards and nurseries from Ohio to the Pacific coast can not be kept permanently free from the bark disease; therefore all persons interested in growing the chestnut in the West as an orchard tree are earnestly advised not to secure any chestnut nursery stock from eastern nurseries; to be sure that stock from any source is rigidly inspected; to watch with the utmost care their own nurseries and orchards; and to destroy immediately by fire any trees that may be found diseased.

There is presumptive evidence that the bark disease was introduced into America on the Japanese chestnut, but until this point is definitely settled orchardists west of Ohio are advised not to import nursery stock of this variety. Seed can probably be imported with a reasonable degree of safety, however.

ADVICE TO OWNERS OF CHESTNUT WOODLAND.

Owners of chestnut woodland anywhere within the area of complete infection are earnestly advised to convert their trees into lumber as quickly as possible. The trees that are not already killed will soon die in any case and the timber will quickly deteriorate in quality. Such trees are a continual source of further infection, and, moreover, large areas of dead chestnut trees, by harboring bark and wood inhabiting insects, are likely to start some insect epidemic. Indeed, with the quantity of dead chestnut timber now standing it will be remarkable if some serious infestation of insects extending to sound trees does not follow.

Owners of chestnut woodland outside the area of general infection are counseled to watch for the first appearance of the disease, and when it appears to cut down immediately all affected trees, bark them, and burn the bark and brush, over the stump if practicable. Such procedure will distinctly retard the spread of the disease in that particular woodland, even if no concerted efforts at elimination are made by neighboring owners. It is to be expected, however, that in all cases of this kind the owner will have the cooperation of the State authorities in a general quarantine movement.

It is almost needless to add that until we know what action is to be taken in all the chestnut-growing States and what the results are likely to be, chestnut woodland is a poor investment. Furthermore, in forest management, as in improvement cuttings, etc., there should be discrimination against the chestnut.

ADVICE TO OWNERS OF ORNAMENTAL CHESTNUT TREES.

Until the future of the chestnut tree is better known, or at least until we know what legalized action is going to be taken in the States concerned, the owners of chestnut-timbered land available for building should pursue a very conservative policy. Houses should not be located with sole reference to chestnut groves or to isolated ornamental chestnut trees. Houses so located should be discriminated against in purchasing homes in so far as the death of the chestnut trees would injure the appearance of the place.

When ornamental trees become diseased they had better be cut down at once and, if practicable, large trees of other species moved in to take their places. In expert hands the moving of large trees is a perfectly practicable and successful procedure and, although more expensive, is much more satisfactory than waiting for nursery trees to grow.[1]

All owners of diseased ornamental chestnut trees are specifically warned against " fake " tree doctors. Large sums of money have been paid out in many cases for treatment that has been worse than useless. Reliable tree specialists will have nothing to do with trees affected with the chestnut bark disease, or, if they do anything, do it with the distinct understanding in advance that it is entirely at the owner's risk. Of course, if an owner desires to employ tree surgeons to experiment, that is another matter.

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[1] In case such action is not immediately desirable or possible, a very good, though temporary, scenic effect can be obtained by lopping off the ends of the larger branches of the dead and dying chestnut trees, removing the bark, and planting some rapid-growing vine at their foot, which soon covers them. One of the best for this purpose is the Japanese kudzu vine (*Pueraria thunbergiana* (S. and Z.) (Benth.), on account of its extraordinarily rapid growth. Such vine-covered stumps must be carefully watched, however, for in a very few years they decay and are liable to be blown over.

ADVANCING POPULAR KNOWLEDGE OF THE DISEASE.

In the localities where infection is general or complete (fig. 1) everyone knows what the chestnut bark disease is and what its symptoms are and everyone appreciates its seriousness; but in these localities it is too late even to attempt its control. On the other hand, in Delaware, Virginia, West Virginia, western and southern Maryland, western Pennsylvania, central and northern New York, Massachusetts, and Rhode Island very few people know the symptoms of the disease. On this account no one notices it until it is thoroughly established, and by the time public sentiment is sufficiently aroused to authorize the necessary legislation and bring about united action for public protection it is too late for such action to be of service. Obviously, then, every effort should be made by all State and other officials having such matters in charge to acquaint every citizen with the prominent symptoms of the bark disease and to familiarize him with the fact that unless prompt and united action is taken there is every indication that the chestnut tree in the States above mentioned will become practically extinct within 10 years.

COOPERATION OF THE DEPARTMENT OF AGRICULTURE.

In this campaign of education the Department of Agriculture will cooperate in the following ways: *Copies of this bulletin or of other publications of this Department relating to the bark disease, and also typical specimens of the disease, will be sent to any person applying for them.* Two specimens will be sent to each person—one showing the appearance of the disease on smooth bark, and the other the later development of the fungus on thick bark. In both these specimens the fungus will have been killed by soaking in formalin, to insure against any infection from this source.

So far as the supply permits, lantern slides and photographs will, upon application, be loaned for special lectures, exhibits, etc., to the officers of States, experiment stations, colleges, and schools where agriculture is taught, as well as to tree wardens and other officials whose work may bear directly upon local campaigns of publicity.

This Department will always examine any suspected specimens of this disease sent to Washington by mail, and will report the findings as promptly as possible. Before sending specimens, however, all persons are urged to read the paragraphs on symptoms on pages 6 to 9 in order to select the specimens intelligently. For example, if the end of a girdled and withered branch is sent, it is not possible to make a dependable diagnosis unless a portion of the girdling area happens to be included. This is the only part where the fungus is surely present, and the fungus itself must be seen in order to be absolutely sure of the disease. Portions of the bark that show the small orange or reddish-brown pustules, about the size of the head of a pin, should always be sent, if these can be found. These commonly occur near the lower edge of the girdling area.

PUBLIC COOPERATION.

With many people familiarized with the appearance of the chestnut bark disease and its possibilities of harm, the disease will be noticed and stamped out by private effort in many places when it first appears and the public will understand and be ready to cooperate in any official measures of control as soon as these become necessary in any locality.

All possible forces must be enlisted in a campaign of publicity. The cooperation of all newspapers, particularly local papers, can be easily secured in all the States where the chestnut is an important tree. A portion of the program for Arbor Day, 1912, should be devoted to a consideration of this disease. Teachers of nature study, botany, or agriculture in the public schools can do great service by teaching their pupils how to recognize the disease and by training them to be on the lookout for its first appearance in the home community. Such a body as the "Boy Scouts" can, if properly trained, become in every community a most efficient force for locating the disease. The boys will readily appreciate that such work is real "scouting" against a most insidious and destructive public enemy. And, finally, many private owners of chestnut trees will be eager to cooperate with the State authorities in the early elimination of advance infections if only they are able to recognize such infections.

THE PROTECTION OF THE SOUTHERN STATES.

It must be remembered that the bark disease has as yet done only a small fraction of the damage that it is undoubtedly capable of doing. The best chestnut timber of America is south of the Potomac River and there the bark disease is present in only a few spots. For this reason it is of extraordinary importance that these few spots be eradicated and that the disease be soon controlled immediately north of the Potomac. If the bark disease once becomes well established in the chestnut forests of the South, it will be well-nigh impossible to control it, on account of the sparsely settled and mountainous condition of much of that country and for other reasons which do not obtain farther north.

SUMMARY.

(1) The chestnut bark disease was first noted near New York City in 1904 and is now present in at least 10 States. It attacks the American chestnut, the European chestnut, the chinquapin, and, rarely, the Japanese chestnut.

(2) The total financial loss from this disease is now estimated at $25,000,000.

(3) The disease is caused by a fungus, and the entrance of a spore at any point where the bark is broken may cause infection. The

disease spreads primarily in the inner bark and produces characteristic lesions which girdle the tree at the point attacked.

(4) Conspicuous symptoms are the development of bunches of sprouts below the girdling lesions; the half-formed yellowish leaves in the spring on the previously girdled branches; the reddish-brown leaves on branches girdled in summer, and the yellow, orange, or reddish-brown pustules of the fruiting fungus on the bark. It is practically useless to attempt systematic location of the disease from October to April, inclusive.

(5) The spores may be carried considerable distances on chestnut nursery stock, tan bark, and unbarked timber; also by birds, insects, squirrels, etc., which have come in contact with the sticky spore masses. Water quickly dissolves these spore masses and the minute spores are in this way carried along with water, as, for instance, with rain water running down a tree. Borers' tunnels form the most common places of entrance for spores.

(6) The only known practical way of controlling the disease in a forest is to locate and destroy the advance infections as soon as possible after they appear and, if the disease is well established near by, to separate the area of complete infection from the comparatively uninfected area by an immune zone. Advance infections should be located by trained observers and destroyed by cutting and burning. As the disease develops almost entirely in the bark, this must be completely destroyed (burned).

(7) In order to carry out the above methods it is essential that the several States concerned secure necessary legislation and appropriations, following the example of Pennsylvania, as no law exists whereby the Federal Government can undertake such work and cooperation among private owners without State supervision is impracticable.

(8) Chestnut nursery stock should be rigidly inspected for the disease and only perfectly healthy plants passed.

(9) The life of valuable ornamental trees may be greatly prolonged by promptly cutting out all diseased areas and removing all disease-girdled branches and then covering the cuts with tar. Spraying is of no use in stopping the fungus after it has once started growth in the bark.

(10) It is recommended that owners of infected woodland cut down and utilize the diseased chestnut timber as soon as possible.

(11) For the present the planting of chestnuts anywhere east of Ohio is not advised, but there is no apparent reason why chestnut orchards west of Ohio may not be kept free from the disease.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 468.

FORESTRY IN NATURE STUDY.

BY

EDWIN R. JACKSON,
Expert, Forest Service.

[Reprint, February, 1912.]

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1912.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., August 29, 1911.

Sir: In 1909 the Office of Experiment Stations, in cooperation with the Forest Service, published for distribution among teachers at the Alaska-Yukon-Pacific Exposition a circular containing a brief tentative outline for a course of forestry in nature study. The requests for that circular and the accompanying correspondence indicated a large demand on the part of teachers for more definite and detailed directions for utilizing trees and forests in nature-study exercises and courses. The circular has therefore been rewritten on the plan (1) of suggesting definitely what tree studies, exercises, and supplementary readings may be used each term in the first six years of the elementary schools, and (2) of making these lessons progressive and logical—this with a view to avoiding fragmentary, unrelated, and unprofitable work, which in the past has been characteristic of much of the public-school nature study. This is not an attempt to introduce scientific forestry into the primary and intermediate grades, but to furnish teachers a guide for the study of trees, with an occasional glimpse into the forest, so that the school children may learn to know and love trees, understand their needs, and comprehend, even though vaguely, their relations to homemaking and farming.

In addition to the course of study, the manuscript as now submitted contains a discussion of the aims of nature study and the methods of teaching it, suggestions for supplementary experiments, field trips, and the use of illustrative material, a key to the common kinds of trees, and a bibliography of the books referred to in the text.

The revision was made by Edwin R. Jackson, expert in the Forest Service, under the direction of Dick J. Crosby, specialist in agricultural education of the Office of Experiment Stations, and is transmitted herewith for publication as a Farmers' Bulletin.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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FORESTRY IN NATURE STUDY.

INTRODUCTION.

THE AIMS OF NATURE STUDY.

One of the chief aims of modern education is to make the child familiar with his surroundings and master of them. As Dr. G. Stanley Hall has said, "To know nature and man is the sum of all earthly knowledge." In order to accomplish these ends, present-day educators have come to devote a great deal of time and attention to systematic study and observation of natural objects, these general studies being classified under the head of "nature study."

The field of nature study is exceedingly broad. All the objects, elements, and phenomena which touch our lives and influence them may be considered as legitimate subjects for study. The possible lines of research are numerous and varied. Among all these possibilities it becomes the duty of the teacher to select those which are most worth while. Nature study has among its chief aims the inculcation in the mind of the pupil of an appreciation and love of the beautiful; his training in acuteness of observation; the development of his reasoning powers by the application of these observations; and the improvement of his powers of expression. Few things in nature fulfill these requirements so well or contribute so fully to the accomplishment of these aims as does the forest. In the forest can be found a wealth of illustrative material; it is replete with myriad forms of vegetable and animal life, and the forest itself, as a whole, is living and active; it is full of the wonderful and the beautiful; it is teeming with lessons of interest at all seasons of the year; and, what is perhaps most important of all from a practical viewpoint, the material for these lessons is accessible to almost everyone. Individual trees alone furnish so many interesting and instructive features that they have come to be favorite subjects for nature-study lessons; but the broader study of the forest, while frequently lost sight of in the study of single trees, offers untold opportunities not only for useful instruction but also as a means of developing and holding the interest of the pupils and of training their keenness of observation.

THE DISTINCTION BETWEEN "TREE STUDY" AND FORESTRY.

It is well to keep in mind the distinction between forestry and "tree study" as commonly found in nature-study courses. "Forestry has to do with single trees only as they stand together on some large area whose principal crop is trees, and which therefore forms part of a forest."[1] It is not the single tree, but the forest, where trees are considered not singly but *en masse*, which must be studied in developing the element of forestry in nature study. The chief work of the forester is so to manage the forest that it will produce a paying crop or to preserve the forest from destruction for its protective influence. From this it will be seen that strict forestry is economic in its aims, while tree study, as usually carried on, is largely esthetic. The practical forester has little to do with the use or growth of ornamental trees, or even with tree planting as concerns merely individual trees. Such work properly falls to the landscape gardener or the horticulturist.

It would be manifestly unwise to attempt to teach scientific forestry, as such, to children in the lower grades. Even in the upper grades and the high school it must be very elementary in its character. Nevertheless, a great many of the general principles upon which scientific forestry is based may be brought within the comprehension of young children. To lead up to the more advanced subject of practical forestry, however, it will be necessary to familiarize the pupil with the life history of the tree and the processes of tree growth. Therefore, especially in the primary grades, tree study, with an occasional glimpse into the forest, should form the basis of the work. As the course develops, more and more time may be given to the forest and less and less to the tree. In the upper grammar grades the study of the forest naturally should be correlated with geography. In the high school, forestry properly claims consideration as a part of elementary agriculture, since the lessons of the wood lot and its management are too important to the farmer to be overlooked. In those high schools where agriculture is not taught as a distinct branch, a great deal of forestry may be taught in correlation with such subjects as physical geography, botany, and manual training. In fact, many of the features incident to the study of forestry must necessarily be considered in the regular work provided for in the ordinary school curriculum.[2] No attempt has been made in this bulletin to suggest any nature-study work above the sixth grade, since it seems desirable that all studies in forestry above this point should be correlated with other subjects, as previously suggested.

The studies outlined in this bulletin need not be given as continuous lessons, but may be taken up at various times during the year as time and opportunity offer. Possibly one period out of every five or six devoted to nature study may be given with profit to the study of the forest. In no sense is this outline intended to suggest that forestry should supplant any other subject, but only to point out some of the interesting and useful things about the forest which every public-school pupil should know if he is to become a well-informed, useful citizen. These things should be used to supplement the regular work assigned to the classes, and will in this way prove helpful rather than burdensome.

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[1] U. S. Department of Agriculture, Farmers' Bulletin 173, Primer of Forestry, Part I.

[2] Suggestive outlines for such work will be found in Forest Service Circular 130, "Forestry in the Public Schools."

METHODS OF TEACHING.

Educators are agreed that children should study *things* rather than *books*, and that these things should be such as are found within the child's ordinary environment. The young child learns almost entirely through the senses—it is busy learning the feel, the taste, the smell, the sound, the looks of the things with which it comes in daily contact. Out of mere curiosity, or because of pure motor activity, the normal child is constantly impelled to new researches, and adds daily to its knowledge the results of its observations, imitations, and experiments. Obviously, then, the best way to teach forestry is to take the pupils to the forest (fig. 1). When it is impossible to go to the forest, specimens should be brought to the schoolroom for study. Suggestions for field studies and for making collections of specimens will be found elsewhere in this bulletin. (See p. 33.)

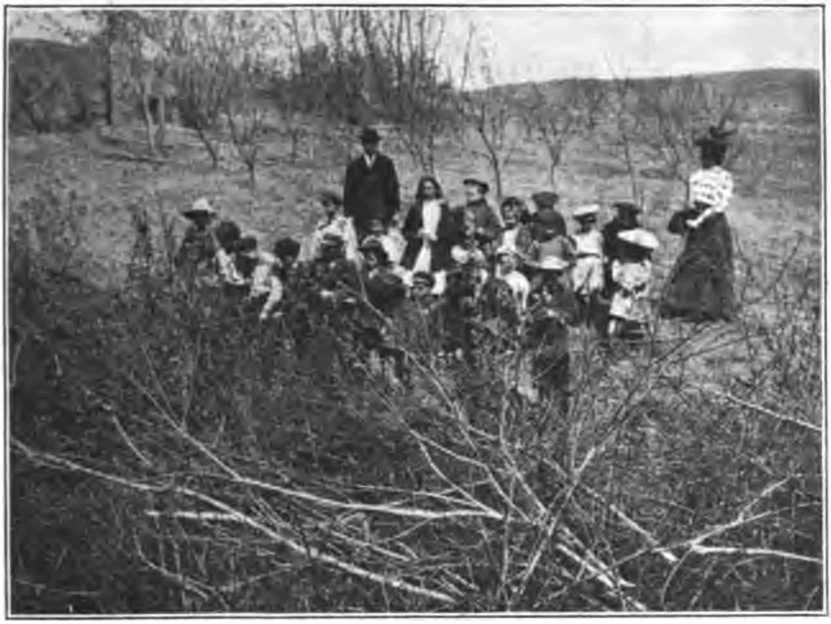

FIG. 1.—Rural school pupils studying forestry.

The more informal these lessons are, the better the results will be. Yet it is important that the teacher assume the task of directing and guiding the pupils in their studies. This can be done effectively by means of stories, talks, and informal questioning. Children's literature is filled with interesting stories of the forest and its inhabitants, some of which are suggested in connection with the outlines in this bulletin. The proper use of these supplemental readings will without doubt prove of great benefit in increasing the interest of the pupils.

If trees are not accessible for study, the next best thing is perhaps a set of well-selected pictures which show forest conditions and various features of tree growth. Such pictures may be found frequently in magazines, geographies, and nature books.[1] An undoubted source of additional interest and instruction will be found in the camera, if one can be carried by pupil or teacher on excursions to the forest. The interesting things seen can then be photographed, and the pictures developed and labeled with descriptions telling something that has been learned about the object. These pictures may be pasted in an album or on a "forest calendar," to become the permanent possessions of the school. (See p. 32.)

The one most important requirement for the success of such work as this, as in all teaching, is the advance preparation of the lesson by the teacher. If a field trip is to be undertaken, the teacher should learn in advance where the class can be conducted to the best advantage and what may be expected from the trip. If specimens are to be collected, the teacher should know whether the material desired is available anywhere in the vicinity and if so how it may be most easily secured and how used to the best advantage. If an experiment is to be performed, the teacher should carefully go over the details in advance, and whenever possible perform the experiment, so as to know what results to expect and what difficulties and sources of error the pupils are likely to encounter. Nothing will be more disastrous to an undertaking of this sort than the lack of a definite plan of work on the part of the instructor. Without it the field trip degenerates into a picnic for the pupils and a tragedy for the teacher; while the classroom exercises will probably be more harmful to the discipline and spirit of the school than they are beneficial.

The outlines given in this bulletin are necessarily very general in character. If they are to be of practical use the teacher must localize the lessons. If the trees named for study are not to be found in the locality of the school, others must be chosen from local species and substituted for them. Exercises and experiments will have to be modified to suit local conditions. These things can not be done by anyone except the person actually on the ground in charge of the work. It is from this application of general principles to local conditions that the greatest benefit will be derived.

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[1] Photographs of trees or forests may be purchased from the Forest Service, U. S. Department of Agriculture, at cost price plus 10 per cent.

OUTLINES FOR A COURSE OF STUDY.

PRIMARY GRADES.

The pupil entering the primary grades of the school is entering a new world. With the home and its surroundings he has already become familiar, but outside the home his experience is limited. The school, with its new regulations, new personalities, and new purposes, is to him strange and often bewildering. It is important, therefore, that his interest be caught from the beginning. To introduce complex or remote subjects for study would clearly be a mistake. Simple objects—those with which he is already more or less familiar—should be chosen, about which he may learn new lessons. The tree, with its leaves, buds, and fruit, is an ideal source of such material, and the lessons here suggested are intended to bring out some new points of interest about the tree and its parts.

FIG. 2.—An Arbor Day program beneath the apple trees.

The chief aims of this work in the primary grades might be summed up as follows: (1) To teach an appreciation of the beauty of trees; (2) to impress the pupil with a sense of the usefulness of trees to man; and (3) to make the pupil familiar with common trees, so that he may be able to identify them at sight by form, bark, or leaf. The exercises outlined in the following lessons have been prepared with these aims in view.

FIRST GRADE.

FALL TERM: Leaf studies.

Trees whose leaves are suitable for study:[1]

Maple
Oak
Elm
chestnut
sassafras
catalpa
willow
basswood
tulip-poplar
walnut
horse chestnut
sumach

Exercises: Gather autumn leaves of trees common to the locality and bring them to the schoolroom. Sort these leaves into piles according to colors. Use bright-colored ones for making wreaths or borders for schoolroom decoration. Can you find any leaves which, as a rule, show brighter colors than those of other kinds of trees?

Select a leaf of simple form, trace or draw it on paper, and color the drawing with water colors, using the leaf itself as a guide.

Sort the leaves according to shapes and become familiar with the names of 8 or 10 common species, so as to be able to recognize them instantly upon sight.

Do you think it is true that "Jack Frost paints the colors on the leaves?" Watch the effect of a frost to find out. Note how quickly the leaves turn brown and fall from the twigs after a sharp frost. If the autumn is mild, without severe frosts, notice how brilliant the autumn leaves become. On the other hand, if there have been early frosts, point out how dull the colors are.

What becomes of the fallen leaves? Of what benefit are they to the seeds and roots buried in the earth, when they cover the ground beneath the trees through the winter?

Supplementary readings:[2]

How the Leaves Came Down. Susan Coolidge. (1, 9, 13)
The Anxious Leaf. Henry Ward Beecher. (1, 16, 23)
The Kind Old Oak. Selected. (8)
The Oak and the Violets. Selected. (18)
The Tree. Bjornstjerne Bjornsen. (8, 9, 13, 14, 16, 23)
Autumn Leaves. The Little Leaves. Geo. Cooper. (13)
October's Party. Selected. (13)
Falling Leaves. Selected. (18)
Nature's Byways. Numerous lessons. (10)

WINTER TERM: Trees in winter. Winter buds.

The following trees have buds suitable for study:

Horse-chestnut
Magnolia
elm
boxelder
beech
hickory
cottonwood
basswood

Exercises: Examine the "scars" on twigs where leaves were attached. What shape are these "scars" on the horse-chestnut? Does this suggest where the tree gets its name? Do all the trees lose their leaves through the winter? Are there some on which the dead leaves remain clinging in spite of winter winds? What do we call trees like the pine on which the leaves stay green all the year? What do we use these trees for at Christmas? Talk about the gifts which the trees bring to us every year—nuts, fruits, wood, etc. Talk about the work of the carpenter, the lumberman, the cabinetmaker.

Just before the buds begin to swell with the approach of spring bring to the schoolroom twigs with large buds and put them in water. Notice how, in a few days, if the room is kept warm, the scales will begin to open. Watch to see if you can discover the little new leaf folded within the bud. Compare the opened buds with others of the same kind brought from out of doors. Study how the scales protect the young leaf in its long sleep through the winter. Examine the scales. Are they smooth, gummy, or fuzzy? Do you think the down or gum you find on some buds would help keep the little leaves dry and protect them from cold?

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[1] These trees are suggested because of the characteristic shapes or colorings of their leaves. Others may be substituted where these species are not found. It will be well at this point to avoid attempting to distinguish species of the same family, since this may be confusing. The selection of a single tree of each kind will simplify the studies and give more satisfactory results.

[2] Throughout the lists of supplementary readings given in connection with each term's work, the numbers following each title refer to the books listed on p. 37, Appendix, in which these selections may be found.

For drawing lessons, use twigs with buds showing the scales and leaf scars.

Supplementary readings:

The Baby Bud's Winter Clothes. Jarvis. (8)
The Venturesome Buds. A. C. (13)
How the Horse Chestnut Got Its Name. Boyle. (20)
Buds. Chase. (6)
Caps and Blankets. Selected. (18)
Ruth and the Pine Tree. Selected. (18)
Waking Too Early. Selected. (18)
Where did the Willow Buds Come From. Selected. (18)
Nature's Byways. Numerous lessons. (10)

SPRING TERM: Tree blossoms.

The following trees have blossoms suitable for study:

Red maple
Pussy willow
Catalpa
elm
oak
birch
flowering dogwood
wild crab apple
tulip poplar
basswood
magnolia
horse-chestnut

Exercises: Explain that the "tassels" of the oak and "pussies" of the pussy willow are really flowers. Now see how many different kinds of tree flowers can be found and brought to the schoolroom. Learn to know the blossoms of 8 or 10 trees (fig. 3).

Watch to see which appear first in the spring—flowers or leaves. Is this order the same for all trees? What insects visit the blossoms of the trees? What are they looking for? Which blossoms do they prefer? Which tree blossoms have no smell? Do the bees visit these as frequently as they do the sweet-scented ones?

Talk about the usefulness of trees for shade and beautification. Study the home building of birds and squirrels in the treetops and the habits of the woodpecker. Study how the leaves, branches, and roots of the trees afford hiding places and shelter to creatures that live in the forest.

For drawing lessons, use the pussy willow, dogwood, or tulip poplar blossoms as studies.

Supplementary readings:

The Walnut Tree that Wanted to Bear Tulips. Wiltse. (7)
Pussy Willow. Kate L. Brown. (8)
Pussy Willow. Marian Douglas. (13)
The Lilac. Clara D. Bates. (13)
How the Apple Blossoms Came Back. Margaret Boyle. (20)
The Apple Blossoms. Selected. (18)
Nature's Byways. Numerous lessons. (10)

SECOND GRADE.

FALL TERM: Nuts and fruits of forest trees.

The following trees furnish material suitable for study:

Chestnut
Walnut
beech
hickory
horse-chestnut
oak
catalpa
locust
crab apple
wild plum

Exercises: Gather small branches bearing nuts or seed pods for study. As far as possible, connect the study of nuts with the leaf studies outlined for the first grade. Learn to identify as many trees as possible by their fruits.

Notice the husk, or outer shell, of the chestnut bur. What is it for? What do the squirrels do with these nuts?[1] Would it be easy for a squirrel to get at a chestnut before the bur opens? Does the nut fall out of the husk or does husk and all fall from the tree? What is the effect of frost on nuts?

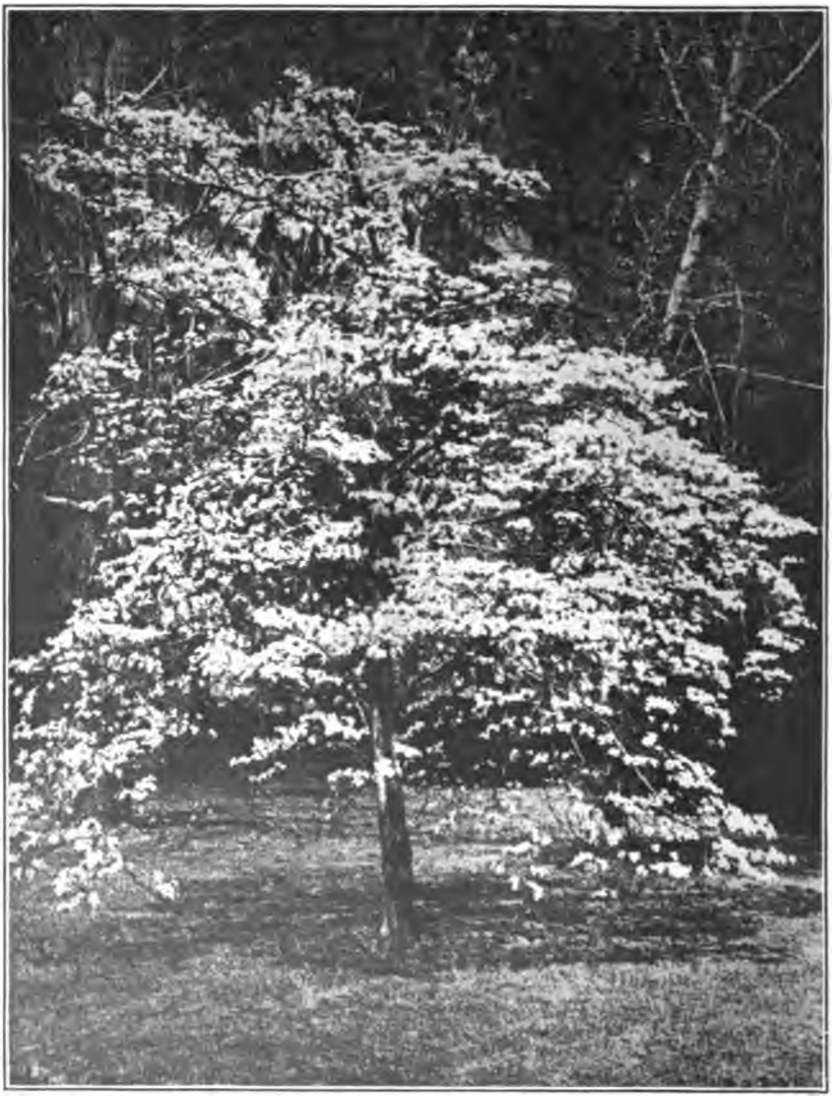

FIG. 3.—Flowering dogwood.

Carefully remove the shell from an acorn and examine the kernel. Into how many parts is it divided? Separate them, and see if you can find the little "sprout" hidden between them. Plant an acorn and see what comes of this.

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[1] For notes on nuts as food for squirrels and other mammals see U. S. Department of Agriculture, Bureau of Biological Survey Circulars 76 and 78, and Farmers' Bulletin 335.

Explain that the kernel of a nut is really the seed of the tree. Now compare the seeds of the locust or catalpa in their pods with those of the apple and plum in their fleshy coverings. How would you tell a *nut* from a *seed?*

What kinds of native nuts are sold at the grocery stores? Find out how much chestnuts, walnuts, and hickory nuts are worth per bushel. Where does the squirrel keep his winter supply of nuts? What nuts does he prefer? Make a list of all the different kinds of nuts and fruits which people like to eat. Can you think of any other articles of food produced by trees? Visit a grocery store and make a list of all the articles kept there which are obtained from trees.

Sketch a chestnut bur, a group of acorns, a hickory nut in its husk.

Supplementary readings:

Why the Juniper Has Berries. Holbrook. (3)
The Maple Sugar Story. Hopkins. (5)
The Chestnut Boys. (8)
Wait and See. Jarvis. (8)
The Chestnut Bur. Selected. (13)
Nutting. Selected. (13)
Little Nut People. Nicholson. (13)
The Gossip of the Nuts. Selected. (13)
The Apple Barrel. Edwin Sabin. (14)

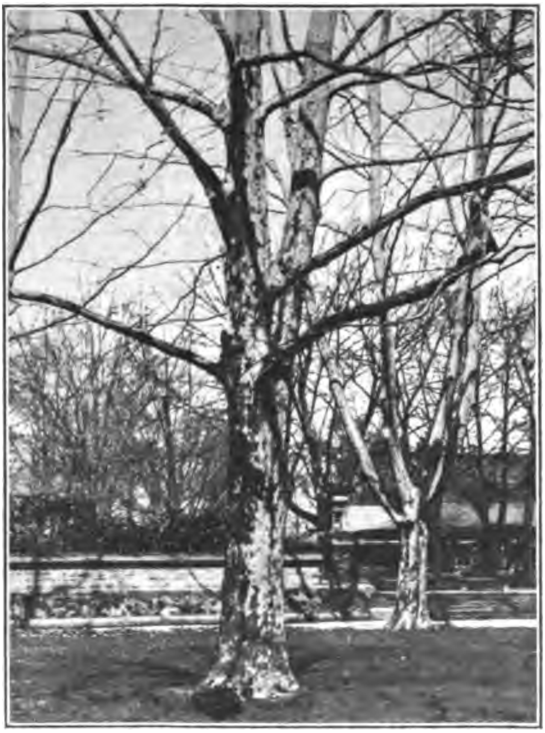

FIG. 4.—The sycamore.

WINTER TERM: The tree trunks, their coverings and uses.

Sycamore
Shellbark hickory
Birch
willow
beech
silver maple
slippery elm
sassafras
black cherry
locust
prickly ash
Osage orange

Exercises: Study the appearance of the bark of trees in the vicinity of the school. What is the difference between the appearance of the old bark on the base of the tree trunks and the new bark on twigs and branches? On an old tree and a young tree? Describe the appearance of the bark on such trees as the sycamore (fig. 4), birch, and shellbark hickory. Learn to recognize 8 or 10 such trees by their bark. Taste twigs of slippery elm, sassafras, etc.

Notice the thorns of hawthorn or Osage orange. Break off a thorn. Does it grow only from the bark, or does the wood extend out into it? Do you think a tree armed with thorns would be so likely to be browsed or trampled by cattle as one without?

Make a list of household articles which are made from wood. What are corks made from? Tell in simple language how coal was formed. Discuss in a story form all the different steps necessary to bring the tree from the forest and manufacture it into pencils, desks, lumber for building the schoolhouse, etc.

Read the story of "Hiawatha's Sailing" and notice how he called upon the trees for material to build his canoe.

Supplementary readings:

How Coal is Made. Wiltse. (7)
Hiawatha's Sailing. Longfellow. (11)
The Christmas Trees. Mary F. Butts. (9)
The Logging Camp. Jarvis. (8)
An Old Fashioned Rhyme. Selected. (8)
The Story of a Stick of Wood. Chase. (6)
The Stump Story; The Log Story; The Rail Fence Story. Hopkins. (5)
The First Christmas Tree. Field. (24)

SPRING TERM: Tree seeds, germination.

The seeds of the following trees either ripen in the spring, or may be kept in storage, or procured on the market, and thus may be available for study in the spring term:

Elm
Silver maple
Cottonwood
oak
catalpa
locust
coffeetree
chestnut
pine
apple
peach
plum

Exercises: Plant newly fallen seeds of elm or maple. Watch to see if they sprout at once or lie in the ground one season. Is this the same for all trees? How long after planting the seed is it before the little tree appears? How many leaves are there at first on the seedling? Do these look like the leaves of the big tree? Watch to see what becomes of these first leaves.

Look for little seedlings which frequently spring up beneath forest trees. Dig up one not more than 2 or 3 inches high and look for the remains of the seed from which it started. If the seedling is from a thick-shelled nut, such as the hickory or walnut, see if you can find out how the tender little seedling got out of the shell. Do you suppose Jack Frost helped it in any way?

Watch the trees to see where and when the seeds form. Learn to know as many as possible of the forest trees by their fruits. Learn whether the seeds ripen early or late.

Plant trees on Arbor Day. Talk about the trees in the school yard or vicinity and how they got there. Who attended the school when these trees were small? Tell how the food stored up in seed or nut feeds the little seedling until its roots get started in the soil and its leaves in the air.

Supplementary readings:

Apple Seed John. Child. (8)
The Maples' Story. Chase. (6)
The Tree that Tried to Grow. Francis Lee. (18, 23)

THIRD GRADE.

FALL TERM: The whole tree.

Renew acquaintance with trees already studied and add some new types, such as the ash, aspen, hackberry, mulberry, and sweet gum.

Exercises: Select some flourishing, dense-crowned tree which is easily accessible and study it. Learn the meaning of the following terms and apply them to this tree: Roots; stem; bole, or trunk; bark; sap; branch; spray; twig; leaf; petiole; foliage.

Watch the tree as it changes with the seasons. What color was it in summer? In autumn? Do the leaves fall early or late? Are the leaves found close to the trunk or near the ends of the branches? What is the reason they are spread out in this way? How does the trunk help the leaves get to the light and air? What holds the trunk upright? How much of the roots can you see above ground? How far do you suppose they extend below ground?

Which trees grow in wet and which in dry places? Are there any caterpillars or insects on or around any of the trees studied? What is the difference between a tree, a shrub, a bush, and a vine? Do any other plants grow as large as trees?

What part of the tree is most used by men? Of what use to man are the leaves? The roots?

Make tree booklets. Include in them pictures of trees, drawings of leaves and fruits, interesting facts about these trees, quotations, etc.

Supplementary readings:

Forest Trees—Mother Truth's Melodies. (13)
Why the Aspen Leaves Tremble. Holbrook. (3)
The Oak. Geo. Hill. (14)
The Brave Old Oak. Chorley. (14)
Our Willows. (Hours at Home.) (16)
The Legend of the Maple. Ogden. (11)
The Red Maple. Thoreau. (11)
A Fairy Story; Philemon and Baucis; Daphne; The Poplar Tree. Cook. (2)
The Oak Tree and The Ivy. Field. (24)

WINTER TERM: Shapes of forest trees.

The following trees are easily recognized by their shapes or their sprays:

Elm	ash	catalpa	horse-chestnut	weeping willow
Oak	birch	Osage orange	Lombardy poplar	Norway maple

Exercises: Study the characteristic shapes of trees, such as those listed, and learn to recognize them by their form alone (fig. 5).

Point out the two distinct types of branching shown by the Lombardy poplar and the elm.[1] Make lists of the trees you know, classifying them as to this characteristic. Notice whether the twigs of the trees are thick and coarse, or divide up into fine sprays. Would a spray lie flat on the table or do the twigs spread out in all directions?

Observe whether these trees branch close to the ground, or if the trunks grow up tall and clean before branching. Do the branches grow out opposite one another or alternately along the trunk? Do they grow out horizontally, or tend upward or downward? Which trees are more likely to be injured by windstorms—the wide-spreading or erect types? Which make the best shade trees? Which trees produce the best posts, poles, and lumber—those with tall, clean trunks, or those with low branches?

Collect pictures of trees in winter, showing characteristic shapes, trees laden with snow. Make drawings in charcoal of general outlines characteristic of various trees.

Supplementary readings:

Miss Willow. Susan Kennedy. (13)
Three Trees. Selected. (13)
The Crooked Fir Tree. Pratt. (20)
The Silver Poplars. Selected. (18)
The Little Vine. Selected. (18)
Forms and Expressions of Trees. Flagg. (23)

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[1] *Excurrent* type: Trunk can be traced up through crown to topmost twig; e. g., the Lombardy poplar. *Deliquescent* type: Trunk divides up into branches, so that no main central stem can be distinguished through the crown; e. g., the elm.

SPRING TERM: The growth of the tree.

Study growing trees. Green twigs of maple, boxelder, willow.

Exercises: Watch the forest trees for evidences of the spring awakening. What are the first changes you notice? Cut off a small branch of a maple or boxelder. What is the watery fluid which flows from the wound? Taste it.

Remove the bark from a green twig and notice the green, moist layer just inside the inner bark. This is what builds the tree. It is called the "cambium" layer. Examine the branch of a boxelder or maple. See if you can distinguish last year's growth from that of the preceding year. Can you tell the new growth of the evergreen twigs from the old parts by the color?

Fig. 5.—Lombardy poplars.

Place a growing plant in the dark and notice the result after a few days. Make a mark on a rapidly growing young seedling at a certain height from the ground and see if the seedling lifts this mark higher in growing. At what season of the year do you think the tree grows fastest? What would be the effect of a cold spring season on tree growth?

Tell in simple way how the tree gets its food from the soil and air; how it is carried up the stem to the leaves to be digested there by aid of the sunlight; how it is sent down through the cambium to be built on the tree as an "annual ring."

Make a "Forest Calendar" on which to record the appearance of evidences of the spring awakening or characteristics of individual trees. (See p. 32.)

Supplementary readings:

The Tree. Jones Very. (13)
The Last Dream of the Old Oak Tree. Hans Andersen. (16)
The Diligent Tree. Selected. (19)
The Real Tree. Holmes. (23)
The Twig that Became a Tree. Anonymous. (23)
How to Make a Whistle. Anonymous. (23)

INTERMEDIATE GRADES.

The studies outlined for the first three grades have had to do almost entirely with simple features of individual trees. Those suggested for the next three grades include studies not only of trees but of the forest, thus broadening the scope of the work. In the upper grades there will be taught, as the regular work of the school, such studies as geography, history, and composition. The forest affords valuable material which may be used to enrich and enliven these subjects. As much as possible, therefore, the teacher should correlate the exercises outlined in the following pages with the regular studies of the school.

It must not be forgotten that an important end to be achieved in all this work is to cultivate the pupil's powers of expression as well as his keenness and accuracy of observation. To know a thing from having seen it is worth while in itself, but to be able to tell others about it is a still greater accomplishment. For this reason especial attention should be given in the upper grades to both written and oral composition based on the studies of the forest. Numerous opportunities in this direction will be afforded by these exercises, such as writing reports of the field trips or experiments and descriptions of the trees and features of forest growth studied.

FOURTH GRADE.

FALL TERM: The forest.[1] Tree families.

The following trees may be studied and compared:

Silver maple	white oak	white elm	pignut hickory	paper birch
Sugar maple	red oak	red elm	shagbark hickory	river birch

Exercises: Compare trees of the same family, but of different species. Do not attempt too many different kinds. Try to be able to recognize and distinguish all the species of some family (as all the maples) found in the vicinity. Collect and mount the leaves of various species for comparison.

Visit the forest. Notice how the trees form a sort of canopy or roof with their branches and leaves. Observe the "understory" of sprouts, seedlings, and small plants. Examine the soil beneath the tree. Do you find partly decayed leaves in it? How do you suppose this loose mold is formed? Sink a spade into the soil beneath the trees and notice how thickly the roots lie in the earth (fig. 6).

Look about at the trees. Are they all of one species ("pure stand"), or is it a mixed stand? Examine a tree in the dense forest and one of the same species growing alone in an open space. What difference do you notice?

Point out how the forest is a society of trees; how the trees help one another by sheltering one another from windstorms and the hot drying sun; how they strive with one another for light, soil, etc. Tell how the forest trees not only protect one another, but shelter and protect birds, squirrels, and other animals which inhabit the forest. Write little stories imagining things that are going on in the forest every day.

Supplementary readings:

Under the Greenwood Tree. Shakespeare. (13, 17, 23)
The Summer Woods. Howitt. (13)
The Gift of the Olive Tree; The Linden and the Oak; The Little Maiden Who Became a Laurel Tree. Judd. (4)
The Autumn Woods. Bryant. (16)
The Old Oak. Selected. (18)

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[1] Farmers' Bulletin 173 contains much information useful in connection with this subject.

A Story of the Forest. Smith, in "The Story Hour."
The Forest. Jefferies. (23)

WINTER TERM: The evergreens.

Trees for study:	Pine	cedar	hemlock	holly
	Fir	larch [1]	spruce	live oak

Exercises: Have the children gather sprays of evergreen and holly and bring them to the schoolroom for study and for decoration purposes. Use the design of the holly leaf and berry in borders and other Christmas decorations.

Sort sprigs of the various evergreens according to length, arrangement, and shape of needles. Learn to know at sight whether the spray is from a pine, a hemlock, a fir, etc. (See Appendix, p. 39.) Draw a spray of pine needles. Note the cones which are found on nearly all evergreens. Remove a few of the scales from a pine cone and see if you can find the seeds which lie near the inner tips. Some of the evergreens have characteristic odors. Crush the needles and learn which ones.

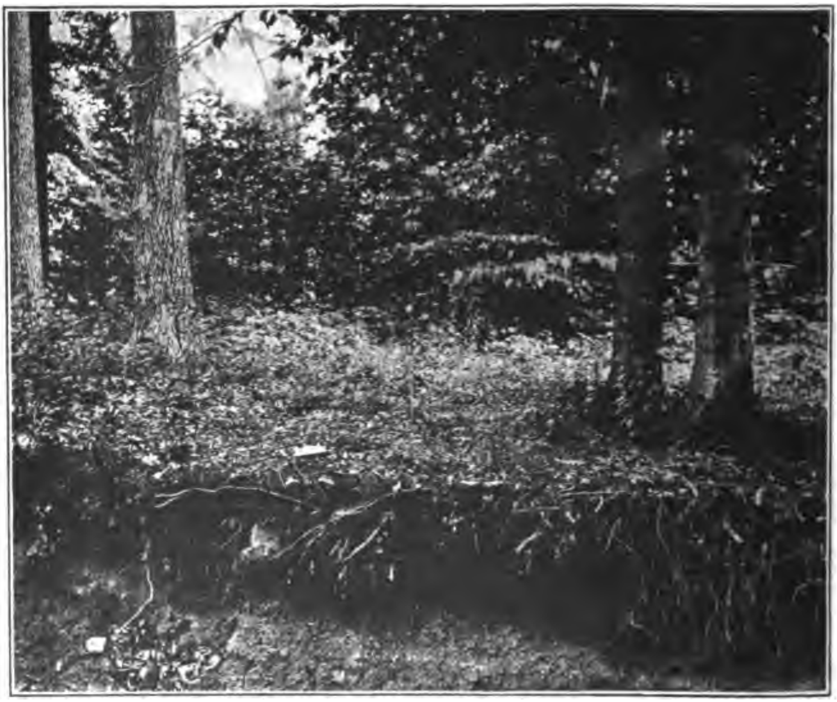

FIG. 6.—The forest floor.

Why may evergreens in general be called "cone-bearing trees?" Do the needles ever fall from the pine trees? Look under a pine tree and see. Call attention to the larch as a *deciduous cone-bearing* tree; to the holly and live oak as *evergreen broadleaf* trees. Note how the snowbirds and sparrows seek the shelter of the evergreens during storms. Which would make a better windbreak if planted about a home, an evergreen or a tree which sheds its leaves in winter?

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[1] The larch is not an evergreen, but is suggested for study here as a type of deciduous, cone-bearing tree.

Point out the advantage of the conical shape of the evergreen in shedding snow. How do trees keep the snow from drifting?

Learn the meaning of the following terms as they are used by the forester and lumberman: Conifer; evergreen; deciduous; broadleaf; hardwood; softwood.

Supplementary readings:

Why the Evergreens Never Lose Their Leaves. Holbrook. (3)
Holly. Susan Hartly. (13)
The Little Pine Tree. Eudora Bumstead. (13)
A Young Fir-wood. Dante G. Rossetti. (11, 17)
The Snowing of the Pines. Thos. W. Higginson. (17, 23)
The Little Pine Tree. Selected. (18)
The Secret of Fire. Cooke. (2)
The Fir Tree. Hans Christian Andersen. (1)

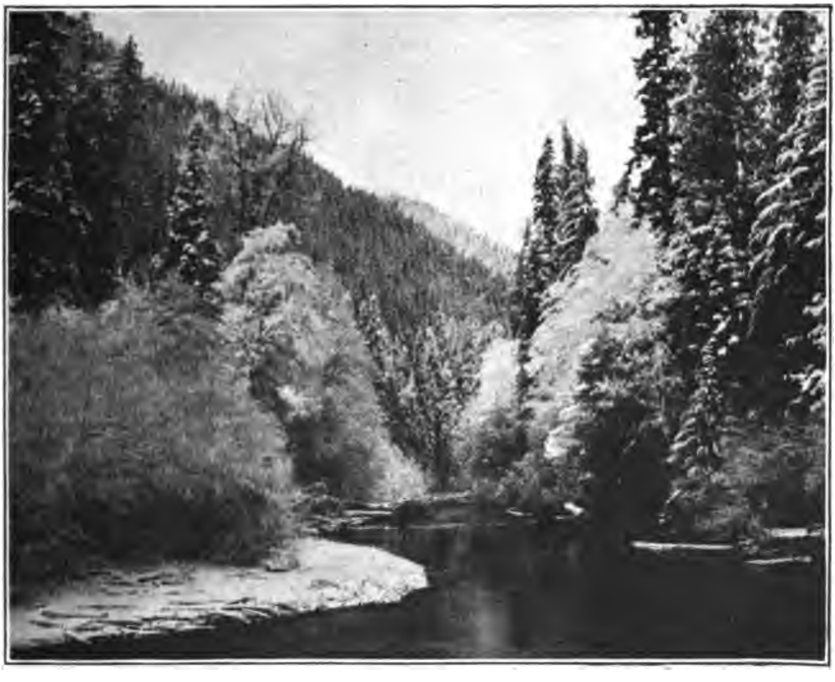

FIG. 7.—Evergreens in winter.

The Little Fir Tree. Evaleen Stein. (1)
The Unhappy Pine Tree. Selected. (1)
The Pine Tree's Secret. Emilie Paulsson. (1)
The Voice of the Pine. Richard Watson Gilder. (23)

SPRING TERM: Tree planting and gardening.[1]

The following species are suggested as desirable and may be obtained as suggested:

Early seeds:	*Stored seeds:*	*Seedlings:*	*Cuttings:*
Elm	locust	pine	willow
Silver maple	catalpa	spruce	cottonwood

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[1] For further information, see Farmers' Bulletins 134, 228, 423; also Forest Service Bulletin 76, Circular 96, and Yearbook Separate 376.

Exercises: Test various kinds of tree seeds to see what percentage may be expected to germinate. (See p. 29.) Prepare a seed bed and sow tree seeds of various kinds. In each row plant a different kind of seed, marked by a stake with proper label. Keep records of time of sowing, time seedlings appear, and how well the seeds germinate.

Plant seeds at various depths in soil and learn at what depth they give best results. Soak some seeds in warm water before planting and plant others of the same kind without soaking. Which sprout better?

Make cuttings of willow and set them out in moist places. Watch for the development of roots and leaves on the cuttings. Where do they appear?

Transplant seedlings of various trees. Compare the roots of nut trees like oak or hickory with those of maple, catalpa, or the conifers. Which are easier to transplant? Try the method of transplanting seedlings in tin cans. (See p. 28.)

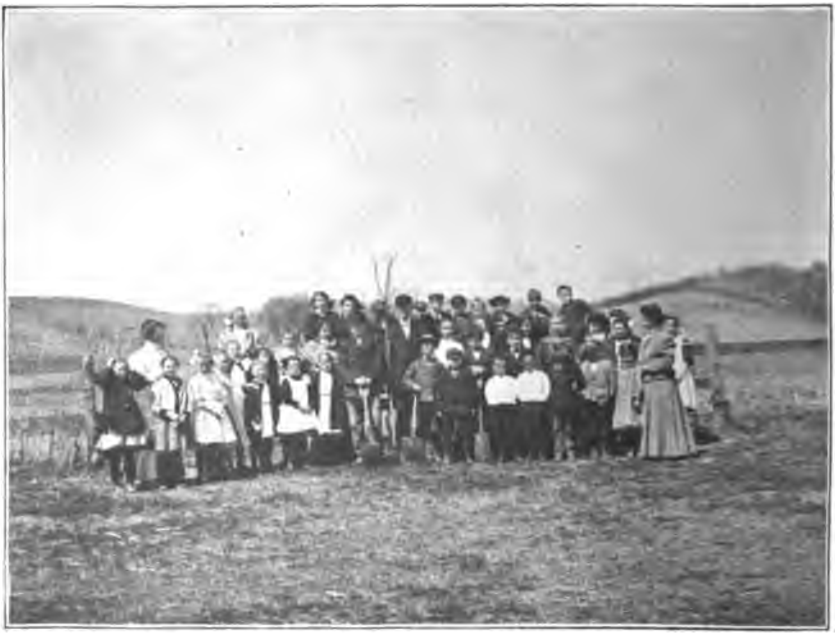

FIG. 8.—Planting trees on school grounds.

Prepare a map of the school grounds and make a "planting plan" to show where trees should be planted to give best effect.

Learn the history of Arbor Day and talk about its significance to the nation. Discuss the supply of forests in the United States; the necessity for tree planting. Discuss the importance of tree planting for the beautification of cities and homes. Are many trees being planted nowadays in your city or on the farms in your locality?

Supplementary readings:

The Four Apple Trees. Selected. (8)
The Planting of the Apple Tree. Bryant. (11, 14, 17, 23)
What Do We Plant When We Plant the Tree. Henry Abbey. (14, 23)
Plant a Tree. Lucy Larcom. (14, 23)
An Arbor Day Tree. H. C. Bunner. (23)

A New Holiday. Curtis. (23)
Arbor Day. Jarchow. (23)
Arbor Day in Schools. Northrup. (23)

FIFTH GRADE.

FALL TERM: Reproduction of forest trees.

The seeds of the following forest trees illustrate adaptation for dispersal:

Boxelder
Maple
catalpa
ash
black cherry
juniper
witch-hazel
pine

Exercises: Collect specimens of various kinds of tree seeds and see if you can find out how they are scattered naturally. Examine winged seeds of boxelder and maple. Throw some of these seeds up into the air in a strong wind and see how far they are carried. Now remove the "wings" from some of the seeds and throw up the seeds without their wings. Compare the distance these are blown with previous results.

Watch the wild cherry and juniper trees to see[1] if the birds eat the fruit. Do they carry away any of the fruit? See if you can find seedlings planted by birds along fence rows (fig. 9). Watch a squirrel hiding nuts in the earth. Do you suppose he always comes back to get the nuts he has buried? What may happen if he doesn't?[2]

Drop acorns and walnuts into a stream and watch to see if they float or sink. Are they carried away by the water or rolled along the bottom?

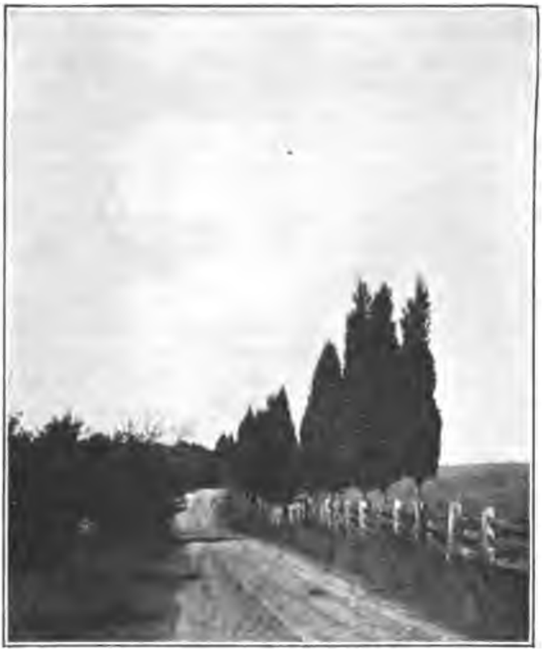

FIG. 9.—Junipers planted by birds.

If witch-hazel grows in the vicinity watch for the exploding of the seed pods and see how far the seeds are thrown. Make lists of trees whose seeds you think are scattered (1) by wind, (2) by water, (3) by birds or animals. Discuss the importance of leaving seed trees on lumbered land. Why do not all the seeds that fall from the trees grow? What enemies have these little seed babies?

Find stumps from which sprouts are growing. Do all trees sprout from their stumps? Make a list of all the trees you know whose stumps will sprout.

Supplementary readings:

The Oak and the Mistletoe Seed. Pratt. (16)
An October Talk. Selected. (18)

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[1] For list of fruits eaten by birds consult U. S. Department of Agriculture Yearbook 1909, pp. 185–196.

[2] Seed-eating mammals in relation to reforestation are treated in U. S. Department of Agriculture, Bureau of Biological Survey Circular 78.

A Broken Branch. Selected. (18)
Why Seeds Travel. Dana. (19)
Winged Seeds. Dana. (19)
The Chestnut and Other Seeds. Dana. (19)

WINTER TERM: Wood structures and uses.[1]

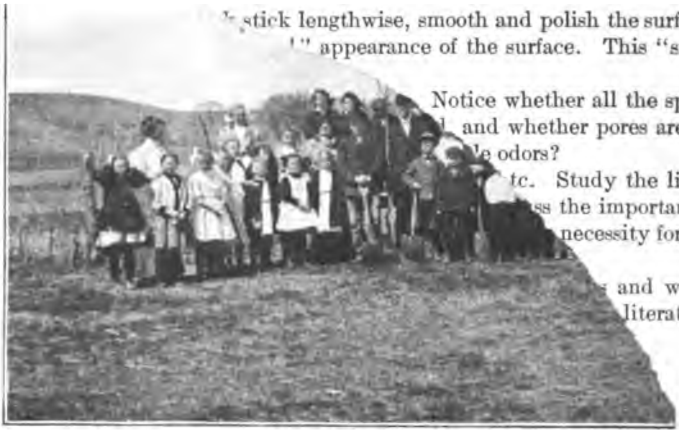
The woods of the following trees will furnish interesting material for study and comparison:

Fir	soft pine	ash	maple
Cedar	hard pine	oak	basswood

Exercises: Get a cross section of a tree trunk or branch of oak or chestnut as large as convenient and observe heartwood, sapwood, and bark; annual rings, with summer wood and spring wood in each ring; pith rays; pores.

Count the annual rings. How old is the tree? Can you point out, from the annual rings, any years when the tree did not grow very well? Measure the diameter of the log. How many years did it take in growing that large? How fast, then, did it increase in diameter each year, on the average?

Find a tree in the forest whose lower branches are dead. Do they leave scars on the trunk when they fall away? If boards were cut from the trunk of this tree, what would these scars form in the boards? What shaped trees yield the



stick lengthwise, smooth and polish the surface with sand-
appearance of the surface. This "silver grain" is

Notice whether all the specimens show
and whether pores are visible in all
odors?
tc. Study the life of the lum-
the importance of wood as
necessity for prevention of

and write what you
literature or history.

FIG. 8.—Planting trees on school grounds.

transplant? Try the method of transplanting seedlings in tin cans. (See p. 28.)

Prepare a map of the school grounds and make a "planting plan" to show where trees should be planted to give best effect.

Learn the history of Arbor Day and talk about its significance to the nation. Discuss the supply of forests in the United States; the necessity for tree planting. Discuss the importance of tree planting for the beautification of cities and homes. Are many trees being planted nowadays in your city or on the farms in your locality?

Supplementary readings:

The Four Apple Trees. Selected. (8)
The Planting of the Apple Tree. Bryant. (11, 14, 17, 23)
What Do We Plant When We Plant the Tree. Henry Abbey. (14, 23)
Plant a Tree. Lucy Larcom. (14, 23)
An Arbor Day Tree. H. C. Bunner. (23)

thermometers, one in the shade of the woods and one in the open, and compare the readings frequently during the spring. Which one registers the higher average temperature? What does this indicate?

After a rain notice how the raindrops cling to the leaves of the trees. Does the rain beat as hard upon the ground beneath trees as on open fields? From which does the rain water run off more rapidly, an open field or one covered with forest? What effect, then, would forests have upon floods?

Find a tree recently uprooted by the wind. Are the roots totally bare or are they loaded with soil? Why does the soil cling so firmly to the roots of trees? Pull up a small seedling tree and wash the soil from its roots. Does it come away easily? Do you think trees will help prevent erosion? Do you know of any places where trees have been planted in ditches to prevent the washing of soil?

Study the forest floor again. Do you find traces of decayed leaves in the soil? Compare the color of this top soil (humus) with that deeper down. What makes the difference? What do you conclude from this is the influence of forests on soil?

Where is the air purer—in the forest or in a large city? Discuss fully the importance of windbreaks to the prairie farmer in moderating winds.

Write a composition on how the trees serve man.

Supplementary readings:

An April Day. Longfellow.
The Pine Tree. Selected. (18)
Pine Trees. Ruskin. (11)
A Forest Hymn. Bryant. (11, 23)
The Forest as a Protective Cover. Roth, in First Book of Forestry.
When the Green Gets Back in the Trees. Riley. (23)
Relations of Trees to Water. Flagg. (23)

SIXTH GRADE.

FALL TERM: Enemies of the forest.[1]

Exercises: Look for trees in the forest that have begun to decay. See if you can find any break in the bark or a wound of some sort where the decay started. Now find some tree from which a branch has been smoothly cut, close to the trunk. Is this wound healing? How is it being covered? What does this teach about how to prune trees?

Cut into a pine tree and watch to see how the tree slowly tries to cover the wound by pouring rosin over it. Look for globules of gum over broken places in the bark of the black cherry, spruce, or balsam fir.

Do you know of any hollow trees in the neighborhood? Does the tree die just because its heart is decayed? Will it resist the wind as well as one whose heartwood is sound? Do you think a tree could live without *any* heartwood, if it would not blow down? Look for "frogstools" on trunks of trees that are beginning to decay (fig. 10).

Watch to see which trees are attacked by insects. Look for caterpillar webs on trees. Do the limbs on which the webs appear seem to be injured as a result? Watch for the beetles that feed upon the leaves and bore in the bark and wood of certain trees. What birds destroy these insect pests?[2] Ought we to protect these birds?

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[1] See U. S. Department of Agriculture, Forest Service Bulletins 10, 82. See also publications of the Bureau of Entomology on insect enemies of the forest.

[2] See U. S. Department of Agriculture, Bureau of Biological Survey Bulletins 7 and 37, on the food of woodpeckers, and Bulletin 39 on the relation of woodpeckers to trees and wood products.

Observe the conditions of the forest floor after the leaves have fallen from the trees. Is there any danger of fires at this period? Touch a match to a bunch of dead pine needles and see if they will burn? Is there more danger of fire in a pine forest than in hardwoods? Watch the newspapers for accounts of forest fires. Study how these fires originate, how they are fought, the extent of the damage they do. How does the United States Government provide for preventing and fighting forest fires? What are the forest rangers? Learn about their lives and duties.

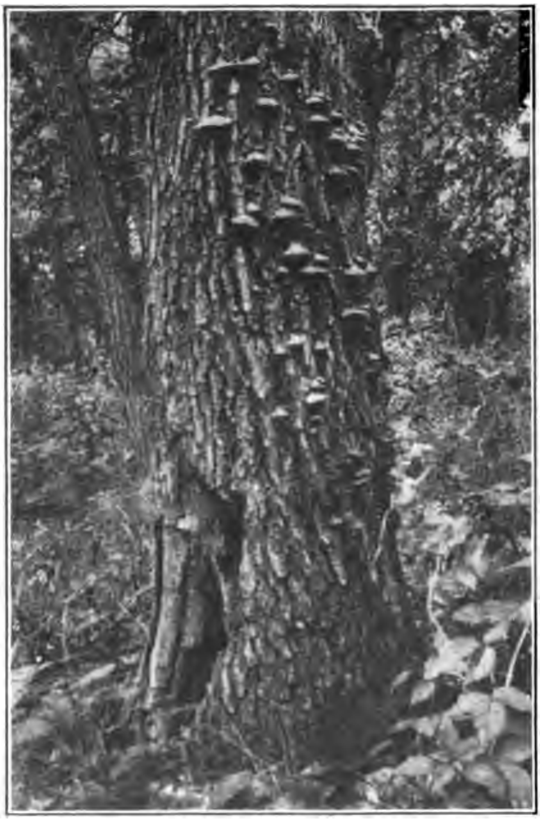

FIG. 10.—"Frogstools" indicate that decay has begun.

Supplementary readings:

Woodman, Spare That Tree. Geo. P. Morris. (11, 23)

A Sermon from a Thorn Apple Tree. Emily Miller. (16)

The Happy Little Birch Tree. Selected. (18)

Forest Trees. Washington Irving. (11)

The Beech Tree's Petition. Thos. Campbell. (11, 23)

A Protest Against Felling the Trees. Wordsworth. (11)

WINTER TERM: Forest industries and the forests of the United States.[1]

Exercises: Make a complete list of all the different trees you have found and identified in your locality. Are these principally conifers or broadleaf trees? In what regions of the United States are the forests chiefly coniferous? Where are the most important broadleaf, or hardwood, forests of the United States? Show these by colors drawn on a map on the blackboard or on paper.

Discuss the various industries in this country which depend upon the forests. Learn how paper is made; how leather is tanned; how turpentine, resin, wood alcohol, charcoal, etc., are obtained; how maple sugar and sirup are manufactured.

Collect samples of various forest products, such as wood pulp, tan bark, maple sugar, crude turpentine, etc., for a forest museum. (See p. 35.)

Learn the present extent of the forests of the United States as nearly as possible. How fast are they being cut down? Do you think they will grow up again as fast as they are cut? What materials are to-day being used instead of wood in buildings, sidewalks, bridges, fences, etc.? What substances may be used to make posts and other timbers last longer? Is this worth while?

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[1] See Report of Forester; U. S. Department of Agriculture, Forest Service Bulletin 83 and Circulars 167, 171; also Farmers' Bulletin 252.

What are the National Forests? Where are they situated? Why are they maintained? How are they controlled? How may the timber on these forests be cut and used? What privileges have settlers in the National Forests as to the use of timber, grass, water, etc.?

Supplementary readings:

From My Arm Chair. Longfellow. (11)
The Maple Tree's Surprise. Mann. (8)
Mr. Maple and Mr. Pine. W. J. Brier. (11)
The Logging Camp; Going Down the River; At the Sawmills. Bradish. (18)
Winter Trees. Wm. A. Quayle. (13)
The American Forests. John Muir. (23)

SPRING TERM: The care and management of trees and forests.[1]

Exercises: Visit the woods, where trees are being cut for logs or posts. Take a small area where the trees are thick and mark those you think should be removed to give the best conditions for the growth of those remaining. In doing this look for defective trees; large trees of undesirable species overshadowing smaller ones of better kinds; trees which have obtained their full growth, or nearly so, which may be removed to give more light to younger, growing trees (fig. 11).

Are the stumps of trees that have been cut low or high? Is there any good wood left in them to go to waste? What has been done with the tops of the trees that have been cut? Has any wood been wasted in them?

Is there any young growth, or reproduction, in this forest? Where do the young trees grow best—under a heavy growth of larger trees or in the clearings? Do these trees produce sprouts from their stumps?

Do the farmers of the neighborhood make a practice of allowing cattle or sheep to graze in their wood lots? Do the cattle or sheep browse the leaves of the young growth? Do they injure the young trees by trampling or rubbing? What do you think of the plan of using a wood lot for grazing purposes?

In a city observe the care taken of street trees. When are they pruned? Why is early spring the best time? Are the young trees protected by guards? Why? Do you find any trees injured by pavement being laid too closely about them? What trees do you think are best for street planting? Why?

Review what has been learned about the various individual species of trees, and learn all you can about their characteristic features, growth, uses, etc.

Supplementary readings: Various readings from—

Ten Common Trees. Stokes.
Trees in Prose and Poetry. Stone and Fickett. (11)
First Book of Forestry. Roth.
Talks on Trees. Holmes. (23)
Wood-notes. Emerson. (23)
A Discourse on Trees. Beecher. (23)

TWELVE SUPPLEMENTARY EXPERIMENTS.

[These experiments may be used whenever time allows, to supplement the work outlined for the intermediate grades.]

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[1] See U. S. Department of Agriculture, Farmers' Bulletins 228, 358; also Silvical and Planting Leaflets, Forest Service.

EXPERIMENT I. How to make leaf prints.[1]

The materials needed for this exercise are a large smooth slate or piece of thick glass about 10 by 12 inches in dimensions; a tube of printer's ink; two 6-inch rubber rollers such as photographers use in mounting prints; and several sheets of good quality white paper.

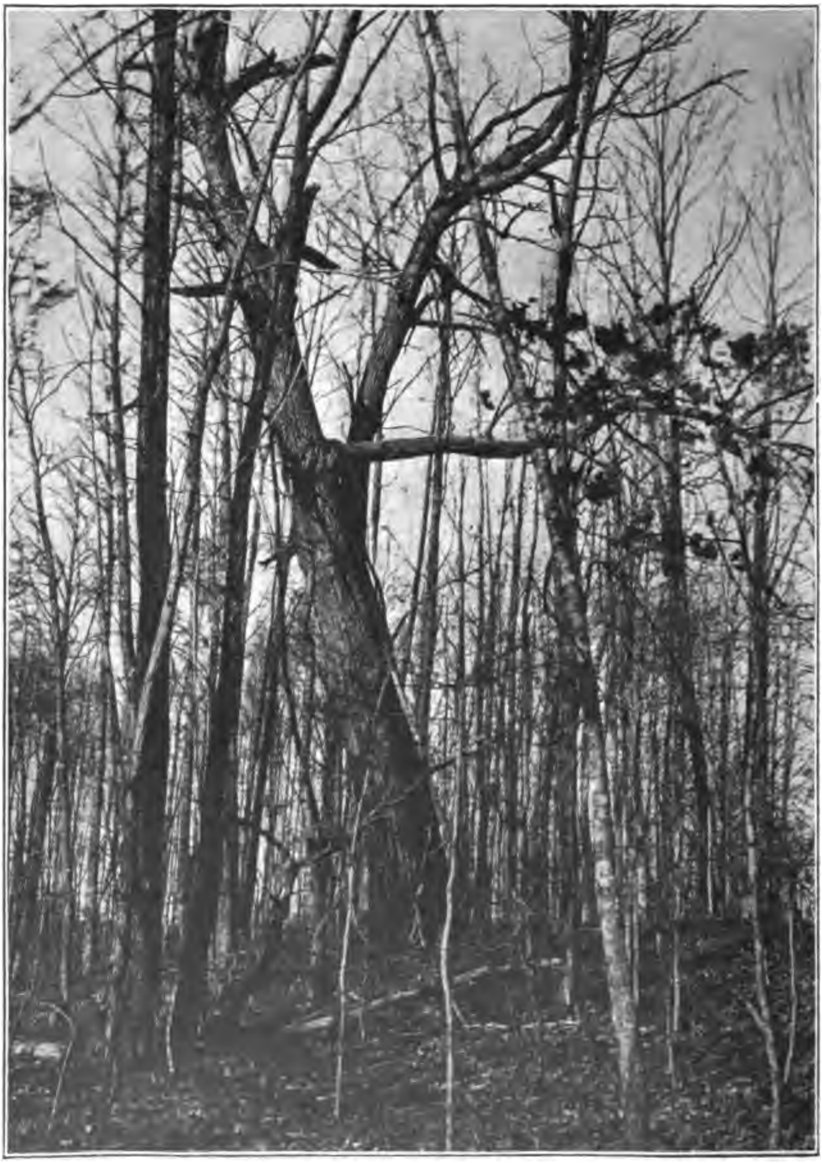

FIG. 11.—A crooked old tree which should be removed.

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[1] The author is indebted to Mrs. Anna B. Comstock of Cornell University for this exercise. Mrs. Comstock gives credit to Prof. W. W. Gillett for the idea.

To make a print, squeeze a few drops of the printer's ink from the tube upon the glass or slate and spread it about with the roller until there is a thin, smooth coat of ink both upon the plate and upon the roller. The ink should never be so thin that it will "run," since it will not then produce a good, clear print. Now place the leaf on the inky surface of the glass and roll it once or twice on the upper side with the inky roller, until both surfaces of the leaf are well inked. Lay the inked leaf upon a sheet of smooth white paper and cover it carefully with another sheet. Take the *clean* roller and roll it *once* only, bearing on *hard*. An impression of the leaf will be made on both the upper and lower sheets of paper.

(For the older pupils, this exercise may be amplified and made much more interesting by using oil colors, which may be brushed lightly over the lower side of the leaf, or spread upon the smooth surface within a sketched outline of the leaf and the leaf then pressed upon them by a roller. The impression on paper is then made by rolling the "painted" leaf with a clean roller on white paper as in the printer's ink process. The lower side of the leaf gives a better print, with this process, than the upper. The colors used should be arranged just as they appear in the leaf itself.)

EXPERIMENT II. To show how the sap travels up the stem.

Color a glass of water with a good quality of red ink. Place some cuttings of live branches of maple or willow in this water over night. The next day split one of the branches and notice how the colored fluid has been drawn into and up these stems. Has it traveled upward in the bark, sapwood, or heartwood?

EXPERIMENT III. To store acorns or nuts for spring planting.[1]

Gather a quart or more of acorns or nuts. Spread them out on a dirt floor in a cellar or shed for two or three weeks to dry. Then prepare a pit, on some well-drained spot, in which to store them. Make the pit about 14 inches deep and 10 or 12 inches square. Line the sides and bottom of the pit with boards or sink a box of the proper size into the hole, to keep out mice and squirrels. Cover the bottom with a layer of clean sand 2 or 3 inches deep. Spread a layer of nuts on this, then another layer of sand, and so on until all the nuts are stored. Then cover the whole with earth to a depth of from 4 to 6 inches, and see that it is well heaped up and rounded so as to drain off all water. Cover the mound thus formed with a roof of boards or shingles. When the ground is ready for planting in the spring remove the nuts from the pit and plant them immediately.

EXPERIMENT IV. The food of a tree.

Bore a hole one-half inch in diameter and 1 inch deep into the trunk of a hard maple, early in February before the sap begins to flow. Make a spout to fit this hole by forcing the pith out of a section of the stem of an elder and fit this spout tightly into the hole. Place a pail under the spout to catch the sap which flows from the spout. Measure the flow for each day for a number of days. When several quarts of sap have been secured place it in a pan and boil it down until it is a thick sirup, then allow it to cool. Watch for the sugar to form. Where did this sugar come from? What use has the tree for such substances?

EXPERIMENT V. To show the effect of girdling a tree.

(Select for this experiment some tree which is to be cut down. Do not try it on a good tree which should not be injured.) Early in the spring remove a strip of bark 2 inches wide clear around the trunk of the tree, leaving the wood entirely exposed. Be sure to cut through the inner bark so as to leave none of it connecting the bark above the girdle to that below. Watch the effect on the tree. Does it show signs of injury immediately or not until late in the summer or the next spring? What is the result eventually? Explain.

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[1] For more complete directions as to storage of seeds, see U. S. Department of Agriculture, Farmers' Bulletin 423.

EXPERIMENT VI. To show that trees give off surplus water through their leaves.

Cut about 6 inches from the tip of a growing, leaf-covered twig of some broadleaf tree, such as a cottonwood, maple, or basswood. Thrust the butt of the twig through a tight-fitting hole in a sheet of cardboard into a glass of water. Cover the twig with an inverted glass wiped clean and dry. Let stand for 12 hours. Note the moisture which gathers in the inside of the inverted glass. Try the same experiment after stripping the leaves from a twig. Where did the moisture come from which appeared on the glass in the first experiment?

EXPERIMENT VII. To transplant seedlings by "tin-can" method.[1]

Get some small, thrifty seedlings about 6 or 8 inches high, growing in nursery beds or in the open, if possible. Dig them up carefully, allowing as much earth as possible to remain clinging to the roots. Get some tin cans, such as tomato cans, in which to plant the seedlings. Across the bottom of the cans make two cuts at right angles to provide drainage and allow the roots of the seedlings to escape. Place the seedlings in the cans and fill in rich earth until they are firmly planted in the cans. They may now be kept in the schoolroom windows if the cans are set in a trough or tray so that the little trees can be watered and tended like ordinary plants. In the spring set out cans and all in places where it is desired to plant trees. The cans will soon rust away and the little trees will continue to grow unchecked.

If desired, seeds can be planted in the cans and the trees grown in this way instead of transplanting the seedlings to the cans.

EXPERIMENT VIII. To estimate the height of a tree; "shadow method."

Set a short pole in the earth near the tree so that the shadow of the pole will fall on ground the slope of which is as nearly as possible the same as that on which the shadow of the tree falls. Measure the height of the pole from the surface of the earth, the length of the shadow it casts, and the length of the shadow cast by the tree. The height of the tree may then be computed as follows: Multiply the length of the tree's shadow by the height of the pole, and divide the product by the length of the pole's shadow.

The proportion may be expressed thus: The height of the pole is to the length of its shadow as the height of the tree is to the length of its shadow.

EXPERIMENT IX. To show where the increase in height takes place in trees.

In the early spring find a vigorous sapling, 2 feet or more in height, with smooth bark, such as a young hickory, box elder, or cottonwood. Cut a notch in the bark at a given height above the ground and another notch about a foot above the first. Record the exact height of the first notch and the distance between it and the second. Now measure the height of the sapling to the topmost terminal bud. Return to the sapling in the autumn and repeat the measurements. How much has the tree increased in height? Has either notch been lifted from the ground? Have the notches grown farther apart? Where has the new growth taken place? Do you think that the tree in growing pushes its whole trunk upward—stretches that part already built—or merely adds on to its height at the top? After a branch has developed from the trunk, would it be lifted higher from the ground by the growth of the tree?

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[1] This exercise is suggested in California Agricultural Experiment Station Circular 59, by E. B. Babcock and Harry A. Greene.

EXPERIMENT X. To show how a tree increases in diameter.

Early in the spring select a young, vigorously growing tree, 3 to 4 inches in diameter, with a thin bark which peels easily; for example, a willow or a box elder. With a sharp knife make a horizontal cut through the bark about 1 inch long. From each end of this cut make a vertical slit extending upward about 1½ inches. Carefully peel back the flap of bark thus loosened (being sure to expose the sapwood) and place a thin sheet of tinfoil beneath the bark on the exposed surface of the wood. Turn the bark back into its place and seal up the incision with grafting wax. Examine the tinfoil at the close of the growing season. Has the deposit of new wood appeared on the inside or the outside of the tinfoil? Which part, then, builds the tree—the cambium layer or the sapwood? How thick is the layer of wood built this season?

EXPERIMENT XI. To test the vitality of tree seeds.

Gather a quantity of small seeds, such as those of elm or maple. Count out from 50 to 100 seeds and place them on a plate between two sheets of moist blotting paper. Record on a slip of paper the number and species of the seeds with the date on which the test is begun. Place this slip on the edge of the plate so it will not get lost or separated from the seeds it represents. Cover the whole with another plate or a pane of glass. Keep in a warm room, in which the temperature is not less than 68°. Keep the blotting paper moist, but not saturated. Examine the seeds every day until all have had time to germinate. This may take two weeks or even longer. When the seeds are well sprouted, count out those which failed to germinate and from this determine the percentage of good seeds.

EXPERIMENT XII. To show that forests prevent erosion of the soil.

Prepare a mound of loose, fresh earth about 2 feet in diameter at the base and from 12 to 14 inches high. Pack the mound quite solidly, so as to approximate the natural condition of the earth's surface. Cover one side of this mound with moss, being careful to leave none of the surface exposed. Thrust small twigs of evergreen into the moss so as to make a minature forest on one side of the mound. Leave the other side bare. Now with a common garden sprinkling pot sprinkle water upon the mound, first on the "forest" side, then on the barren side, from a height of about 3 feet or more. Note how the water gullies the bare slope, running off in muddy streams at the base of the mound on this side, while on the other, the "forest-covered" slope, is protected from erosion and the water remains clear. Note also that when the sprinkling is begun the run-off is more rapid from the barren slope than from the moss-covered side. What does this show as to the possible effect of the removal of forests from mountain sides?

SUGGESTIONS FOR FIELD TRIPS.

Field trips furnish at once the best and the most difficult means of studying the forest. They enable the pupil to study the trees at first hand in their natural state, which is without doubt the ideal method. (Fig. 12.) But this method is difficult, because the pupils generally feel that the discipline of the schoolroom relaxes as soon as the threshold is crossed and that study is impossible without the necessary accompaniment of books. It is no easy task to train young children, accustomed to the order and routine of the schoolroom, in the art of outdoor study. An outdoor lesson, therefore, will require the most careful preparation if it is to yield results commensurate with the effort and time required.

An aimless trip is likely to be a disastrous one. The first duty of the teacher then is to lay out a careful plan for the undertaking. To do this, it will be advisable, if not necessary, for the instructor to go over the ground in advance, looking for features which may be studied with a view to economy of time, effort, and distance to be covered on the coming trip. A memorandum should be kept of special features which may be called to the attention of the pupils. This will enable the instructor to refresh his memory on important details and prevent embarrassing and time-wasting delays. This advance trip will also serve to increase the teacher's stock of information and arm him with a reserve fund of knowledge better than he can obtain from any reference books which he may consult.

In some localities the first problem will be to find a satisfactory place to which to conduct the pupils—a place that is easily reached where material suitable for study may be found. In other localities choice must be made of several possible routes. Much will depend upon the forest conditions of the vicinity as to the nature of the work planned. Of course it is highly desirable that a large tract of closely wooded land be the field of operation, but even if a few trees along some stream are all that can be found there will still be opportunity to teach some of the elementary principles of forestry.

FIG. 12.—A trip to the woods.

Having decided on a route to be followed, the next step will be to plan the equipment for the trip. In most cases no tools will be necessary but a sharp hatchet, a spade, and several sharp jackknives, such as every boy habitually carries. A market basket should also be provided in which to carry home specimens. A camera will lend additional interest to the occasion and enable the possessor to bring back pictures which will refresh the minds of the students and permanently illustrate the lessons learned. A magnifying glass or hand reading glass of moderate power is also desirable.

The most important step, however, in getting ready for a field trip is the preparation of the minds of the pupils. They must be interested to a point where they will look forward to more than a mere pleasurable excursion. The trip must seem to them an unusually interesting sort of lesson, but nevertheless an actual part of their school work.

The experience of most teachers has probably been that children are easily interested in anything which partakes of the nature of a story. As a means, then, of catching the interest of the pupils, it is a good plan for the teacher to give a series of simple talks about trees and their habits, bringing out in this manner as many as possible of the features which the pupils will have opportunity to observe on the trip. Tell them that if they look carefully they may see these things for themselves. Encourage a spirit of friendly rivalry among the pupils to see who can find the things mentioned first and who can report on the largest number.

Each child must feel that he is to be held responsible for this lesson quite as much as if it were from his books. Some sort of a report or composition, based on the things seen and learned, should be required of at least the older pupils. Each of these trips can usually be made the basis of several lessons in composition and will thus serve a double purpose. With the younger pupils the same end can be achieved by oral discussions of the features studied.

One other thing should perhaps be mentioned. A great lesson which should be taught to every pupil is the proper care and preservation of the forests. All studies of this sort should be thoroughly constructive, and never destructive. Make it a rule, therefore, never to dig up a seedling which promises to develop into a useful tree, unless it is to be transplanted to a better location. Never cut a branch that there is no reason for cutting—there are plenty that may be cut and the trees from which they are removed left the better for the pruning. Be careful, also, in cutting such limbs, not to leave ragged, projecting stumps which may make wounds the trees will be unable to heal over and thus cause decay and permanent injury to the tree. Care in this respect will more than repay any effort in discipline it may cost.

SUGGESTIONS FOR A FOREST CALENDAR.

Get some sheets of 3-ply bristol board or mounting board and cut them into sheets of a size which will be convenient for a wall calendar—for instance, 8 by 10 inches. Prepare one sheet for each month. A pad containing the calendar dates may be purchased for a small sum at any stationery store. The pages containing the dates for the various months may be separated and one mounted on each page of the calendar.

Now select some phase or condition of forest life, suitable for study each month. Select, also, certain trees which typify this phase or condition. One tree may be studied each month, or each week, as time offers or inclination permits. The following topics and trees are suggested. Others may be substituted, as desired.

September: "Leaf Fall."
  Trees: Walnut, post oak, holly, larch.
October: "The Fruits of Forest Trees."
  Trees: Chestnut, hawthorn, Scotch pine, juniper.
November: "The Coats of Forest Trees."
  Trees: Sycamore, shagbark hickory, birch, honey locust.
December: "Shapes of Forest Trees."
  Trees: White elm, Lombardy poplar, balsam fir, weeping willow, juniper or red cedar.
January: "Lumber from Forest Trees."
  Trees: White pine, white oak, cypress, hickory.
February: "Miscellaneous Products of Forest Trees."
  Trees: Longleaf pine, sugar maple, tanbark oak, spruce, hemlock.
March: "Tree Planting."
  Trees: Pin oak, jack pine, catalpa, ginkgo.
April: "Tree Blossoms."
  Trees: Flowering dogwood, red maple, tulip-poplar, magnolia, wild cherry.
May: "Leaves of Forest Trees."
  Trees: Aspen, horse-chestnut, cedar, hemlock.
June: "Seeding of Forest Trees."
  Trees: Cottonwood, boxelder, basswood, cherry.

The calendar may be used to illustrate these topics in various ways. One way would be to mount on each of the pages of the calendar pictures of one or more of the trees listed under each month, and to write opposite each picture a description of the tree and the interesting thing which it stands for in relation to the topic assigned for that month. For example, in connection with the general study of "Leaf Fall" in September, it could be pointed out that the walnut is a typical deciduous tree; the post oak is a deciduous tree whose leaves, while dying each autumn, frequently cling to the twigs through the winter; the larch is a type of deciduous, cone-bearing tree; while the holly is an evergreen, broadleaf tree.

Additional facts of interest about each tree may be recorded on the calendar. The pupils should be encouraged to watch for peculiarities in the habits of various trees and report them to the school; as for example, when the tree blossoms, when the leaves and fruit appear. Each pupil thus contributing to the calendar might be rewarded by the entry on the calendar of the fact discovered, together with his name as the first one to report it.

In addition to this material, facts concerning the forest in general, learned through actual observation, should also be entered. The teacher may also select from literature quotations about the trees being studied for the pupils to memorize. After each tree has been thoroughly studied, a good supplementary exercise in composition may be had by asking the pupils to write out in story form all they have learned about the tree.

Where pictures can not be obtained, leaves of trees may be pressed and mounted upon the calendar pages; or specimens of the wood used in the same manner; or leaf prints made in the manner suggested on page 26 of this bulletin may be used. If there is a pupil of artistic talent in the school, water-color drawings of trees, leaves, or fruits will make beautiful contributions to the calendar.

When completed, the calendar may be hung upon the school walls as a souvenir, and it will not only be interesting from that standpoint, but will be instructive as well, and extremely useful for reference by future pupils and teachers.

SUGGESTIONS FOR A FOREST MUSEUM.

Nothing can be of greater benefit to a pupil who is studying about the products of the forest than actually to see and study these products, both in the raw and the manufactured forms. It will be well worth while, therefore, for any school which attempts to study the forest in any manner whatever, to begin at as early a date as possible to collect samples of forest products and other materials which will give information about the industries in which these products are used or manufactured.

Specimens for such a collection may be obtained from various sources. Some may be obtained directly from trees in the vicinity. The local grocery stores, drug stores, or hardware stores will supply a great many. Others may be obtained by exchange with schools in other localities if it is possible to get into communication with them. If enough local interest is aroused in the subject, it will frequently be found that patrons of the school will contribute to the project either by helping to bear the expense or by donating material.

The success of the undertaking will depend largely on how the specimens collected are prepared for use. First of all, they should be carefully labeled so as to tell exactly what the articles are, where they were produced in the raw state, from what trees procured, their use commercially or otherwise, and any other information desirable for reference. Specimens of manufactured products should be arranged in series to show the processes and stages in manufacture wherever possible. A suitable case or cabinet with glass front, dust-proof if possible, will be found extremely desirable in order to protect the specimens from handling and from dust when not in use. If a suitable cabinet can not be procured ready-made, one can easily be made by any carpenter or cabinetmaker.

COLLECTIONS OF WOOD SPECIMENS.

The pupils should be encouraged to make collections of specimens of woods found in the locality of the school. A number of possible ways of preparing and mounting such specimens will doubtless suggest themselves, but the following method is recommended as likely to prove convenient and satisfactory.

1. Whenever possible, use seasoned woods for the specimens. If nothing but green wood is available, cut rough sticks and allow them to dry as thoroughly as possible before preparing the finished specimen.
2. Collect specimens as nearly as possible uniform in size and character as to the parts of the trees and ages of the trees from which they are taken. If some are taken from the branches and some from the trunks, or some from young saplings and others from old trees, they should be marked accordingly.
3. For each specimen, select a stick about 2 or 3 inches in diameter and cut from it a section about 4 inches long, sawing the ends squarely across. Split or saw this block through the center and smooth the split or sawed surface so as to show the grain longitudinally. Beginning about 1 inch back from the end on the bark-covered surface, cut with a sharp knife out to the end at the flattened surface, so as to slope one end. Now, if the wood is thoroughly dry and well seasoned, sandpaper the flat surfaces well. If it can be done, it will add to the appearance of the specimen to apply a single coat of thin varnish or shellac, so as to bring out the grain. The specimen is now ready for mounting.
4. Probably the best plan to follow in mounting a specimen is to insert a small screw eye into the square-cut end of the block prepared as above described, and hang it on a hook in the wall or in a cabinet. This will make it possible to take the specimens down for use in the classroom. It will also be possible to pack them in a small space, if it is desired to move them about. Another fairly satisfactory method of preparing and mounting specimens is shown in figure 13.
5. Great care should be taken to see that each specimen is properly labeled. When the sections are first cut they should be carefully marked so as to make it easy to identify each one, and these marks

should be kept on the specimens until they are finally labeled. The label should state the name of the tree; whether taken from trunk or branch; whether from an old tree or a sapling; locality and habitat; and, possibly, a brief statement as to the uses of the wood, especially in the case of woods like hickory or oak which are used in making implements, furniture, or other special articles.

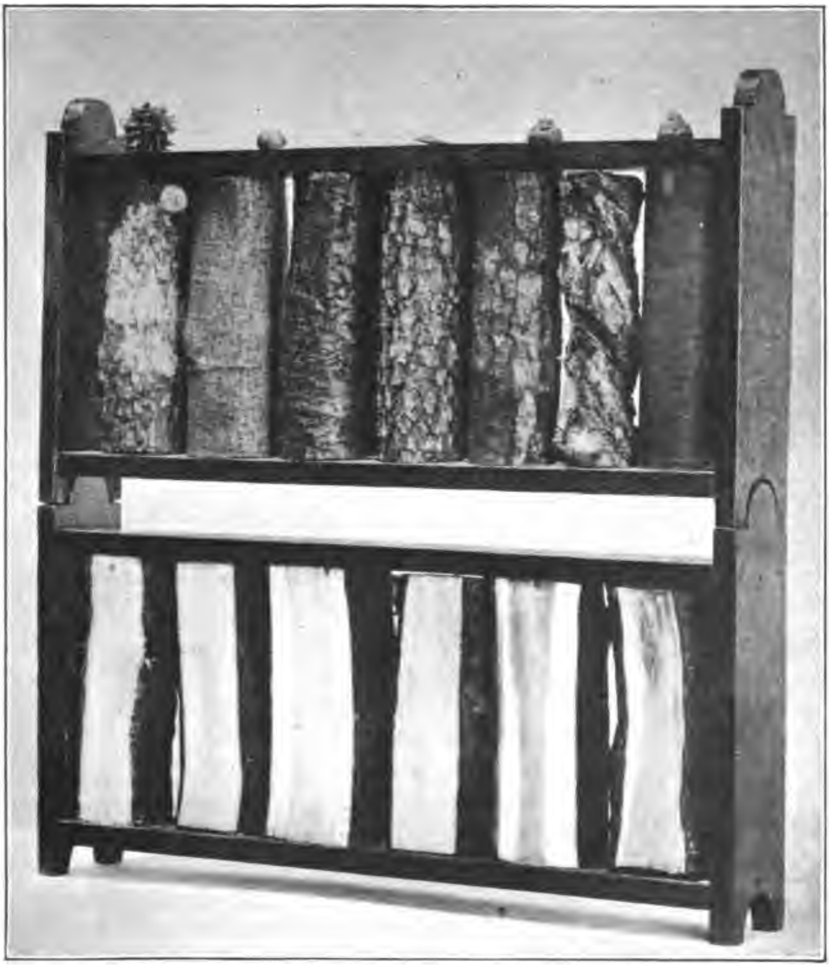

FIG. 13.—Method of mounting tree specimens.

COLLECTION OF COMMERCIAL PRODUCTS OF THE FOREST.

.The grocery store, drug store, and housewares store will yield a great variety of products derived originally from the forest. An interesting plan will be to try to secure samples or specimens of all such products, not only in the manufactured form in which they appear on the market but also in the raw state and in various stages of manufacture. A suggestive list of such products is given below:

Food products, such as the nuts and fruits of forest trees; maple sugar and sirup.

Medicinal products, such as quinine from cinchona, salicin from willow bark, oil of sassafras from sassafras bark, etc.

Small household articles, as matches, toothpicks, clothespins, pencils, penholders, tool handles, wooden baskets, shoe pegs, and wooden dishes.

Oils, such as eucalyptus oil, beechnut oil, olive oil, etc.

The products of wood distillation, as wood alcohol, acetates, wood tar, and common potash from wood ashes.

Paper and wood pulp in various stages of manufacture.

Naval stores and their related products, such as turpentine, rosin, creosote, and pitch.

Miscellaneous products, such as cork, tannic acid, charcoal, spruce gum, lampblack, excelsior, etc.

Some of the products listed, such as maple sirup and sugar, turpentine, wood alcohol, and the various gums and fluids, must, of course, be kept in vials, properly labeled. Perishable fruits should be preserved in alcohol in small jars. Other articles, such as specimens of paper or small articles of woodenware, may be mounted on sheets of cardboard, with labels pasted on the cardboard.

THE USE OF THE MUSEUM.

The materials collected for the Forest Museum should be *used*, not merely displayed. As far as possible the specimens should be so prepared that they may be handled and closely studied by the pupils without injury. Interest soon wanes in blocks of wood or samples of wood products shut up behind glass cases or protected by the warning sign of "Hands off." The child wants to handle the objects he studies, not merely to gaze at them through panes of glass. The materials should be gathered by the pupils themselves as much as possible. They should be encouraged in thinking of the collection as *their* museum. It would defeat this aim to deprive the pupils of the privilege of using and handling the specimens, since they could not but feel that they have a right to use what is their own.

Of course there will be some specimens, the rare or delicate ones, which will not bear handling and must necessarily be used for display only. But the real value of the museum will come from the "working collection." It is suggested, therefore, that the wood specimens, the samples of wood products, the sets of pictures, or whatever material be obtained for the museum, be prepared and arranged with the aim of use constantly in view. If, in addition, provision can be made for the display of the materials when not in use, this should not be neglected. But at all events the use of the materials should not be sacrificed for the sake of making an attractive display.

APPENDIX.

SUPPLEMENTARY READING BOOKS.

(There are published numerous books containing stories, poems, or short articles, suitable for supplementary reading purposes with reference to these studies of trees and the forest. The following books have been selected as illustrations. Specific reference to the selections contained in these books will be found in connection with the outlines for each term's work.)

1. McMurray: Classic Stories for Little Ones.
2. Cooke: Nature Myths.
3. Holbrook: Book of Nature Myths.
4. Judd: Classic Myths.
5. Hopkins: The Sandman and His Farm Stories.
6. Chase: Buds, Stems, and Roots. (Vol. II, Field and Forest Series.)
7. Wiltse: Kindergarten Stories and Morning Talks.
8. Poulsson: In the Child's World.
9. Wiggin and Smith: Posy Ring.
10. Ford: Nature's Byways.
11. Stone and Fickett: Trees in Poetry and Prose.
12. Stokes: Ten Common Trees.
13. Lovejoy: Nature in Verse.
14. Stevenson: Days and Deeds.
15. Quayle: In God's Out of Doors.
16. Pratt: Little Flower Folk. (Vol. III, Field and Forest Series.)
17. Wiggin and Smith: Golden Numbers.
18. ———: Stories from Garden and Field. (Vol. V, Field and Forest Series.)
19. Dana: Plants and Their Children.
20. Winnington: The Outlook Story Book.
21. Bradish: Stories of Country Life.
22. Boardman: The Lovers of the Woods.
23. Schauffler: Arbor Day.
24. Field: A Little Book of Profitable Tales.
25. Price: The Land We Live In.

REFERENCE BOOKS FOR NATURE STUDY TEACHERS.

Nature study (containing outlines or chapters on forestry, or helpful suggestions on general methods of tree study):

Comstock: Handbook of Nature Study for Teachers and Parents.
Coulter and Patterson: Practical Nature Study.
Cummings: (a) Nature Study for Primary Grades.
(b) Nature Study for Lower Grammar Grades.
Holtz: Nature Study.
Hodge: Nature Study and Life.
Holden: Real Things in Nature.
Jackman: Nature Study for Grammar Grades.
McMurray: Special Method in Elementary Science.
Overton and Hill: Nature Study.
Scott: Nature Study and the Child.

Tree Books:

Apgar: Trees of the Northern United States.
Brisbin: Trees and Tree Planting.
Britton: Trees.
Chase: Cone-Bearing Trees of the California Mountains.
Collins and Preston: Key to New England Trees.
Dame and Brooks: Handbook of Trees of New England.
Emerson and Weed: Our Trees and How to Know Them.
Flagg: A Year Among Trees.
Going: With the Trees.
Hough: Handbook of the Trees of the Northern United States and Canada.
Huntington: A Study of Trees in Winter.
Jepson: Trees of California.
Keeler: Our Native Trees.
Lounsberry: A Guide to the Trees.
MacFarland: Getting Acquainted With the Trees.
Mathews: Familiar Trees and Their Leaves.
Maury: The Native Trees of Kentucky.
Mosher: Fruit and Nut Trees.
Mosher: Our Cone-Bearing Trees.
Mosher: Oaks and Maples.
Newhall: Trees of Northeastern America.
Rogers: Among Green Trees.
Rogers: The Tree Book.
Rogers: Trees Every Child Should Know.
Sargent: A Manual of Trees of North America.
Schwartz: Forest Trees and Forest Scenery.

Park and Street Trees:

Fernow: The Care of Trees in Lawn, Street, and Park.
Solotaroff: Shade Trees in Towns and Cities.

General Forestry:

Bruncken: North American Forests and Forestry.
Fernow: Economics of Forestry.
Fernow: A Brief History of Forestry.
Gifford: Practical Forestry.
Graves: The Principles of Handling Woodlands.
Green: Principles of American Forestry.
Roth: A First Book of Forestry.

Wood Structure and Woodworking:

Boulger: Wood.
Foster: Elementary Woodworking.
Hough: American Woods (containing thin sections of various species of woods).
Snow: Principal Species of Wood.

KEY TO COMMON KINDS OF TREES.

By William H. Lamb,
Scientific Assistant in Dendrology.

The following key is intended only as a guide in the identification of the more common kinds of trees. It is based on prominent, distinctive characters which can readily be observed by those who have no special training in botany. Most of the terms used require no explanation.

To use the key, decide first, by an examination of the leaf, in which of the following seven sections your tree belongs; then turn to that section and from the descriptions there given determine what kind of tree it is.

Section.

- Trees with needles, or scale-like leaves, mostly evergreens, bearing cones... I
- Trees with broad leaves.
  - Leaves simple
    - Alternately attached to twigs.
      - With toothed edges.......... II
      - Edges neither toothed nor notched.......... III
    - Opposite on twigs.
      - With toothed edges.......... IV
      - Edges neither toothed nor notched.......... V
  - Leaves compound.
    - Alternately attached to twigs.......... VI
    - Opposite on twigs.......... VII

THE CONIFEROUS[1] TREES.

I. Trees with Needles, or Scale-like Leaves, Mostly Evergreen, Bearing Cones.

A. Leaves needle-shaped.

1. Leaves clustered.
   - a. Leaves long, from 1 to 18 inches, 2 to 5 in a cluster. Cones large, with many thick, woody scales..............(*Pinus*) **Pine**
   - b. Leaves short (less than 2 inches long) in brush-like clusters of 12 to 40; falling off in winter. Cones very small, with thin scales; remaining on tree for one or more seasons..........(*Larix*) **Larch**[2]
2. Leaves single.
   - a. Leaves scattered around twigs; falling off when dry or dead. Cones elongated, with thin scales. Twigs roughened by leaf-scars.
     - x. Leaves stiff, often sharp-pointed and more or less four-sided..........(*Picea*) **Spruce**
     - y. Leaves soft, flat, rounded, or notched at ends, the bases abruptly contracted into thread-like stems..........(*Tsuga*) **Hemlock**

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[1] Cone-bearing.

[2] The larches are peculiar in having single, scattered leaves on the new or terminal twigs produced each season. These should not be mistaken for the "single" leaves borne throughout by other kinds of evergreens.

b. Leaves in two distinct rows, one on each side of the twig; falling off in late autumn or winter. Cones small, ball-like ....(*Taxodium*) **Bald cypress**

c. Leaves often in two rows on the tops and sides of the twigs; leaves on lower branches mostly flat, those on upper branches stouter. Cones long, erect, forming only on upper side of topmost branches; the scales falling off in autumn, leaving spike-like central axes of the cones attached..(*Abies*) **Fir**

B. Leaves scale-like, pointed, overlapping closely on flat or four-sided twigs.

1. Twigs four-sided. Cones round or ball-like, with small, thick scales; seed with very narrow, hard wings..........(*Cupressus*) **Cypress**

2. Twigs flattened.

a. Cones elongated, with only a few thin scales; bent back on branches...................................... (*Thuja*) **Arbor vitae**

b. Cones round, very small, berry-like with thin scales; seeds with a broad, thin wing on two sides....(*Chamæcyparis*) **Cedar**

c. Cones berry-like (showing no separation into scaly parts). Leaves either short, scale-like, and sharp-pointed, or much longer, needle-like, standing out loosely, and attached in pairs or in threes on the twigs.....(*Juniperus*) **Juniper**

THE BROADLEAF TREES.

II. Leaves Simple, Alternate, with Toothed Edges.

A. Leaves deeply lobed, or with large notches.

1. Leaves as wide as they are long. Fruit a swinging ball, 1 to 1½ inches in diameter.

a. Leaves with finely toothed margins; star-shaped, the divisions pointed. Fruit, bur-like balls, from which, when ripe, small, winged seeds may be shaken. Bark rough. (*Liquidambar*) **Sweet gum**

b. Leaves with smooth margins, 3 to 5 inches long, pointed lobes, the space between the lobes rounded. Fruit, a rough ball, easily broken when ripe; composed of closely packed, long, narrow seeds which have hair-like bristles at their lower ends and are attached to a bullet-like central part. Old bark of trunks and large limbs peeling off in thin, curled pieces, leaving pale inner bark showing in irregular patches................................(*Platanus*) **Sycamore**

2. Leaves longer than wide.

a. Leaves large with deep, round-topped, or pointed lobes. Fruit, an acorn, resting in a separable cup ....(*Quercus*) **Oak**

b. Leaves small, with little, sharp teeth on margin. Twigs bearing sharp thorns. Fruit small (like a little apple) round, with bony seeds (hard core).........(*Cratægus*) **Hawthorn**

B. Leaves one-sided (one side of leaf shorter at base than the other side).

1. Leaves large, oval, 5 to 10 inches long, heart-shaped. Fruit, a cluster of small, woody balls ⅓ to ½ inch in diameter, hanging from a narrow, leaf-like blade..........................(*Tilia*) **Basswood**

2. Leaves 3-veined at base, with long, tapering points, which generally turn to one side; edges smooth, or with small teeth of uniform size. Fruit, a small berry about ¼ inch in diameter....(*Celtis*) **Hackberry**

3. Leaves with straight veins, oval; edges double-toothed (little teeth on the larger ones). Fruit in clusters, dry, flat, with papery wings all around the seeds................................(*Ulmus*) **Elm**

C. Leaves even sided (both sides of leaf the same length).

1. Leaves oval, evergreen, thick, with short needle-like teeth. Fruit, a bright red berry..(*Ilex*) **Holly**
2. Leaves more or less elongated, with one tooth at the end of each side vein.
    - a. Trees with smooth, bluish-gray bark, and long, pointed, chestnut-brown buds. Fruit, a small, three-cornered nut, in a spiny husk which splits open at the top into three parts ....(*Fagus*) **Beech**
    - b. Trees with ridged, grayish-brown bark. Fruit, a large, round nut in a thick husk covered with dense, needle-like spines; the husk splits open from the top into 3 or 4 divisions....................................(*Castanea*) **Chestnut**
3. Leaves very narrow, finely toothed. Small branches slender, usually tough. Fruit, a long cluster of little pods filled with "cotton"..(*Salix*) **Willow**
4. Leaves somewhat triangular in outline, broad at base, large-toothed. Buds of some species coated with aromatic gum. Branches coarse. Fruit, a long cluster of little pods filled with "cotton"......................................(*Populus*) **Poplar**
5. Leaves oval, pointed, with sawlike teeth.
    - a. Fruit like a tiny pine cone.
        - x. Bark of trunk and branches peeling off in thin sheets. Leaves double-toothed (little teeth on the larger ones). Fruit ("cones") scaly, falling apart when ripe; seeds with gauze-like wings on two sides.(*Betula*) **Birch**
        - y. Bark smooth or broken, but not peeling. Leaves with small teeth. "Cones" hard, woody, not falling apart; seed with narrow wings on two sides.(*Alnus*) **Alder**
    - b. Fruit, a berry; fleshy, edible.
        - x. Leaves large, 3-veined at base, often irregularly, deeply lobed; containing milky juice. Fruit similar in appearance to a blackberry ......(*Morus*) **Mulberry**
        - y. Leaves small or medium-sized, feather-veined; containing green juice; fruit (cherry or plum) with one seed.
            - i. Seed ("stone") flattened. Fruit large and short-stemmed....................(*Prunus*) **Plum**
            - ii. Seed round. Fruit small and long-stemmed. (*Prunus*) **Cherry**

III. Leaves Simple, Alternate, Edge neither Toothed nor Notched.

A. Leaves with deep lobes.

1. Leaves with blunt ends (appearing as if cut off), and with two, pointed, side lobes. Flowers tulip-like. Fruit cone-like, pointed, upright, composed of long, thin, overlapping, winged seeds. Bruised twigs have a peppery odor..........(*Liriodendron*) **Tulip Poplar**
2. Leaves with rounded ends; oval, often with a lobe on one side, making the leaf mitten-shaped. Bruised twigs and inner bark of trunk sweet-smelling ....(*Sassafras*) **Sassafras**

B. Leaves without lobes.
  1. Bruised twigs with peppery odor.
    a. Leaves oval (evergreen in one species) or elongated, pointed, large. Flowers large, at ends of branches. Fruit cone-like, with a bright red seed in each division..(*Magnolia*) **Magnolia**
  2. Bruised twigs without peppery odor.
    a. Leaves broader at top than at the base, 8 to 12 inches long, with very short leafstalk. Fruit fleshy, elongated, 3 to 4 inches long, with thick, brown skin when ripe, and large, bony, flat seeds. Buds brown and hairy..(*Asimina*) **Papaw**
    b. Leaves oval, elongated, 3 to 7 inches long. Fruit, plum-like, round, 1 to 1½ inches in diameter; when ripe, pale orange color; on a very short stalk, surrounded at base with old, hard flower-cup. Fruit very bitter, but edible after frost..............................(*Diospyros*) **Persimmon**
    c. Leaves rounded or heart-shaped, 3 to 5 inches across. Flowers pea-like, pink, appearing before the leaves. Fruit, a dry flat pod, 2½ to 3½ inches long; in dense clusters on sides of branches; seeds, hard, small, oblong, ¼ inch long....................................(*Cercis*) **Red bud**
  3. Bruised or cut twigs and leaves with milky juice.
    a. Leaves with narrow points. Twigs bearing thorns. Fruit, a large, orange-like, rough ball 4 to 6 inches in diameter. (*Toxylon*) **Osage orange**

IV. Leaves Simple, Opposite, with Toothed Edges.

A. Leaves with large (often lobe-like) teeth. Fruit in pairs, each part with a conspicuous, flat, very thin wing. Fruit matures in spring or in autumn, when it becomes dry and yellowish-brown................(*Acer*) **Maple**

V. Leaves Simple, Opposite, Edges neither Toothed nor Notched.

A. Leaves very large, heart-shaped. Flowers showy, trumpet-like, in large clusters. Fruit, a long, cylindrical pod, 6 to 14 inches long, containing closely packed, flat, dry seeds, with fringed wings at each end..(*Catalpa*) **Catalpa**

B. Leaves rather small, oval, tapering at base and point. Flowers conspicuous, white (occasionally rosy), appearing with the expanding leaves. Fruit, a small cluster of two-seeded berries, turning red in autumn. (*Cornus*) **Dogwood**

VI. Leaves Compound, Alternately Attached to Twigs.

A. Leaflets small, many, attached along two sides of a main stem. Fruit, a flat, bean-like, dry or fleshy pod.
  1. Leaflets with small, wavy teeth. Pods flat, broad, long, often twisted, thin-skinned, with thick, cheesy, sweetish pulp about seeds. Trees with long, keen, branched thorns.(*Gleditsia*) **Honey locust**
  2. Leaflets not toothed.
    a. Twigs with pairs of short, keen thorns. Leaflets rounded at ends. Flowers showy white, in large clusters. Pods small, flat, thin, dry, with small seeds....(*Robinia*) **Black locust**
    b. Twigs thornless. Leaflets oval, pointed. Flowers greenish, with violet odor. Pods large, flat, thick, with jelly-like pulp (poisonous) around the large, black-brown seeds...............................(*Gymnocladus*) **Coffee tree**

B. Leaflets large. Fruit, a hard-shelled nut, with a separable husk.
  1. Leaflets narrow at base becoming larger at outer end. Nut light-colored, in a husk which separates more or less completely into four parts when ripe.................................(*Hicoria*) **Hickory**
  2. Leaflets broad at base, becoming narrower at outer end. Nut dark, rough, in a fleshy husk which is inseparable by any natural divisions and turns black when old. Pith of twigs forms numerous cross-partitions.......................................(*Juglans*) **Walnut**

VII. Leaves Compound, Opposite on Twigs.

A. Leaflets arranged along two sides of a main leafstalk, with a leaflet at the end.
  1. Leaflets generally 3 (sometimes 5), toothed only near the ends. Fruit, a cluster of dry, winged seeds, arranged in pairs like those of maple ....(*Acer*) **Boxelder** [1]
  2. Leaflets generally more than 3 (3 to 11), and either not toothed or with small teeth. Fruit, a cluster of single-winged, dry, oar-shaped "seeds".....................................(*Fraxinus*) **Ash**

B. Leaflets (5 to 9) clustered at end of a main leaf-stem. Fruit, a shiny, brown nut in a thick, warty or prickly husk, which separates into several parts ....(*Æsculus*) **Buckeye**

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[1] Boxelder, a true maple, differs from the others in having compound leaves.

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FARMERS' BULLETIN 469.

Experiment Station Work,

LXVI.

Compiled from the Publications of the Agricultural Experiment Stations.

LAWNS.
FERTILIZING ASPARAGUS.
TURNIPS FOR SHEEP.
LOSS OF LAMBS.
COST OF MARKET MILK.
PROPAGATION OF STARTERS.
THE PLASTERED SILO.

SEPTEMBER, 1911.

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THE AGRICULTURAL EXPERIMENT STATIONS.

Alabama—
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Tuskegee Station: *Tuskegee Institute;* G. W. Carver.[1]

Alaska—*Sitka:* C. C. Georgeson.[2]
Arizona—*Tucson:* R. H. Forbes.[1]
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Colorado—*Fort Collins:* C. P. Gillette.[1]

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State Station: *New Haven;* E. H. Jenkins.[1]
Storrs Station: *Storrs;* L. A. Clinton.[1]

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Sugar Planters' Station: *Honolulu;* C. F. Eckart.[1]

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Rice Station: *Crowley;*
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Pennsylvania—
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State College: Institute of Animal Nutrition, H. P. Armsby.[1]

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Wisconsin—*Madison:* H. L. Russell.[1]
Wyoming—*Laramie:* H. G. Knight.[1]

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[1] Director.
[2] Special agent in charge.

EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[1]

PERMANENT LAWNS IN THE SOUTH.[2]

Anyone familiar with the difficulty of securing good permanent lawns, particularly in the South, will appreciate the value of the results of experiments on this subject recently reported by C. C. Newman of the South Carolina station. In these experiments extending over nine years Prof. Newman tested 35 varieties of grasses and clovers to determine their suitability for lawn making. He says that "the first winter only a few of the varieties of grass were injured by the cold, but the following summer many of them died out completely on account of the drought. After the third year it was evident that our permanent lawns would have to be composed of one or more of the following grasses: Kentucky blue grass, Bermuda grass, herd's grass, and white clover."

The land on which the experiments were made had been under clean culture for several years, no grasses or weeds being allowed to mature seed.

The land was sown in peas in May, the vines being cut for hay in September. The pea stubble was then turned under with a two-horse hill-side plow, followed by a two-horse subsoil plow. The soil was harrowed repeatedly until a perfect seed bed was formed, and the seed sown the first week in October.

Six tons of manure that had been thoroughly composted and 300 pounds of lime were applied per acre before the land was plowed. After the land was plowed 600 pounds of fertilizer analyzing 8 per cent of phosphoric acid, 4 per cent nitrogen, and 5 per cent potash was applied per acre and thoroughly incorporated with the soil by harrowing. Each year, about the middle of March, nitrate of soda was applied to each plat at the rate of 75 pounds per acre.

It was found that a combination of Kentucky blue grass and Bermuda grass is especially well adapted to partially shaded lawns.

As Bermuda grass delights in the sun and the blue grass in the shade or where it is partially protected from the sun, these two grasses make a good combination for a permanent lawn in a grove or where there is an occasional large tree. The blue grass will predominate in the more shaded portions of the lawn and the Bermuda in the open, sunny places.

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[1] A progress record of experimental inquiries published without assumption of responsibility by the department for the correctness of the facts and conclusions reported by the stations.

[2] Compiled from South Carolina Sta. Bul. 157.

[To convert a Bermuda sod into a blue grass-Bermuda lawn] the Bermuda sod should be turned in September with a two-horse turning plow and harrowed thoroughly in order to pulverize all clods and make the land as smooth as possible. The manure and fertilizer should then be applied and worked into the soil with a harrow. About the 15th of October the blue grass should be sown and lightly rolled after raking or harrowing in the seed. The Bermuda will make no growth until the following spring, which will afford ample opportunity for the blue grass to become well established before the Bermuda starts to grow.

Kentucky blue grass thrives best on a clayey or clayey loam soil, yet when sown on sandy loam soil with good clay subsoil and with a northern exposure, it does well, provided the seed are sown in the early fall. If the seed are sown in the spring, the plants do not become well established before the hot, dry weather of summer and frequently by fall much of the grass is dead. If the seed are sown in the early fall, the grass will become well established before cold weather and will not be injured by the freezes of winter or to any great extent by drought in summer. The seed should be covered lightly by raking with a short-tooth smoothing rake and lightly rolled. If a large area is sown, the seed may be covered by means of a light spiked-tooth harrow, set with the teeth sloping at an angle of about 45°. Blue grass is a perennial, and spreads rapidly under favorable conditions by sending out many underground stems or root stocks which form a very compact sod. The seed should be sown at the rate of 35 to 40 pounds per acre.

Where neither blue grass nor white clover can be grown successfully, Bermuda is one of the very best grasses for a lawn. It will thrive on almost any kind of soil or exposure, yet it does best on land with a slight slope to the south or east. In the course of one year the Bermuda will form a compact sod. The roots should be planted either in the spring or fall. They may be scattered broadcast over the land before plowing or may be planted in rows about 2 feet apart, and by fall will have covered the ground. The lawn should be mowed several times during the summer or grazed in order to keep down weeds that would otherwise shade the Bermuda and check its growth to some extent. Bermuda is a perennial, and spreads rapidly from long, creeping, and branching stolons. It does not produce seed in the South and is therefore generally propagated by roots.

For large lawns around country homes or in large groves where a coarse grass is not obtainable, there is nothing better than orchard grass and red clover. The seed should be sown in October, using 8 pounds of red clover and 2 bushels of orchard grass per acre. Red clover and orchard grass will grow from 18 to 24 inches tall and will produce two crops of hay in a season. It should be cut a few days after the orchard grass is in full bloom. Orchard grass and red clover are both perennial.

Where a quick, temporary lawn is desired there is nothing better than Italian rye grass. * * * Italian rye is an annual when sown in the fall, but when sown in the spring will live over until the next year, when it will produce seed and then die. It may be used to advantage when sown in connection with Bermuda grass. For instance, if one desires to establish a sod of Bermuda, the roots may be planted in the fall and the ground then seeded to Italian rye grass. It will make a good sod six weeks after seeding and will not interfere with Bermuda, provided it is grazed or mowed several times during the season. After the second year the Italian rye grass will disappear, and the Bermuda will by this time have formed a good sod.

FERTILIZING ASPARAGUS.[1]

Methods of fertilizing asparagus have been discussed to some extent in a previous bulletin of this series,[2] in which it was stated that salt may be used with benefit in the small asparagus bed of the garden, that early spring applications of nitrate of soda are not likely to be of benefit in securing an increased cut of stalks the same season, and that, if the land is in good condition, a well-balanced commercial fertilizer may produce as good yields as manure and may be cheaper.[3]

On the basis of more recent experiments and observations C. P. Close and others, of the Maryland Experiment Station, make the following suggestions regarding soils and fertilizers for field culture of asparagus:

> Almost any well-drained soil with plenty of humus in it will grow asparagus, but a good rich sandy loam is best. In preparing the ground for planting it should be deeply plowed and have large quantities of rotted manure worked into it. The asparagus grower must use whatever commercial fertilizer he has most faith in, because experimenters and growers do not agree as to what is best. Perhaps 1,000 to 2,000 pounds of kainit per acre in midseason is as good as anything, however, if a complete fertilizer is preferred the following is good: 400 pounds dissolved rock, 400 pounds kainit, and 200 pounds nitrate of soda in early spring.
>
> The very best plants are strong 1-year-olds. About the only advantage in using older plants is to wait until they bloom so as to distinguish the males from the females and select the males which are the strongest and best producers.
>
> After being thoroughly worked up the ground should be laid off in furrows 6 to 8 inches deep and from 4 to 6 feet apart. The best time for planting is early in the spring. The plants are set about 2 feet apart in the furrows and where they are placed the ground is often mounded slightly. The roots are spread out carefully and the earth is filled in 2 or 3 inches over the plants or "crowns" and as growth proceeds the ground is cultivated in until the furrows are finally filled. Thorough cultivation should be continued during the entire season and in late fall the tops should be cut off and removed from the field and be burned to destroy disease germs and insects.
>
> The second year a good coating of stable manure, or 1,000 pounds of kainit per acre, or both, should be applied early in the spring and the entire surface should be plowed 4 inches deep. After thorough harrowing the shoots may be given time to grow a few inches, when cultivation should be begun and be repeated every 10 days or 2 weeks during the season. In late fall the stalks are again cut off and removed for burning. No cutting for market should be done the second year.
>
> The third and succeeding years a light covering of rotted manure, about 5 tons per acre, should be given during the winter or early spring every year if possible, or every second year certainly. In connection with this manure some commercial fertilizer should be used, either a complete fertilizer as mentioned

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[1] Compiled from Maryland Sta. Bul. 151.

[2] U. S. Dept. Agr., Farmers' Bul. 233, p. 11.

[3] For a complete account of asparagus culture see U. S. Dept. Agr., Farmers' Bul. 61.

below or kainit 1,000 to 2,000 pounds per acre. If manure is not available then a complete fertilizer must be used in early spring, at least 400 pounds dissolved rock, 400 pounds kainit, and 200 pounds nitrate of soda.

The ground should be plowed and harrowed again in early spring.

The kind of stalks desired for cutting, whether green or white, will determine how the ground will be handled at this time. If "green" stalks are wanted the ground may be left nearly level or at most only a slight ridge be made over the row.

If "white" stalks are desired, furrows from each side must be thrown over the row to form a round or flat topped ridge 8 or more inches high. There are special asparagus plows which do this ridging to perfection. The stalks must grow through the ridge and are blanched by doing so. The ground must be kept cultivated to keep down weeds.

As soon as the cultivating season is over in June, the entire ground is plowed about 4 inches deep and well harrowed. The shoots are then allowed to grow. Good cultivation must be given so that large amounts of plant food may be stored up in the roots and crowns to produce strong shoots the following year. After the tops die in the fall they should be removed and burned as before.

This treatment is given year after year as long as the plants are profitable.

The use of salt is not considered necessary. The above-described system of fertilizing, especially the use of kainit, furnishes a large amount of the same constituents supplied by salt and this probably renders the use of the latter unnecessary.

TURNIPS FOR SHEEP.[1]

T. R. Arkell, of the New Hampshire Experiment Station, finds that turnips in the winter ration materially reduce the cost of mutton production as compared with rations commonly used, and that under New Hampshire conditions they can be raised and stored at a cost low enough to compete with silage and in many cases may profitably supplant silage for sheep feeding. They thus offer a partial solution of the problem of securing a substitute for high-priced grains. He states that the chief danger in the use of turnips lies in heavily overfeeding or attempting to make them constitute the bulk of the ration, in which case they are liable to make the ration too laxative and produce scouring. On the other hand, owing to their watery nature, turnips render the ration more palatable and are distinctly useful when fed in moderate quantities in conjunction with hay and grain in preventing constipation and other resultant ills which so frequently occur when sheep are changed from pasture to dry feed.

In the experiments upon which these conclusions are based turnips were fed at the rate of 5 pounds per animal in connection with $\frac{3}{4}$ to 1 pound of mixed grains (oats, bran, and corn in equal parts by weight) and $1\frac{1}{4}$ to 2 pounds of clover hay, the daily cost of the ration being $3\frac{1}{2}$ cents per animal.

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[1] Compiled from New Hampshire Sta. Bul. 152.

LOSS OF WINTER-FED LAMBS.[1]

A trouble resembling apoplexy in human beings has for several years been causing large losses among winter-fed lambs near Batavia, N. Y., a region where feeding lambs for the winter market is a large industry.

The lambs are bought largely in Buffalo or Chicago, fed for a period of three and one-half to four months on a highly fattening ration, and when fat are shipped back to Buffalo to be slaughtered. Two crops of lambs are fed each year. The first lot is bought about November 1 and is marketed in February. They weigh about 60 pounds at purchase. It is considered that the greatest profit is realized when they are marketed in 90 to 120 days at a weight of 80 to 85 pounds. If the feeders are able to dispose of their first crop early in February, they usually get another lot to be finished as early as possible up to June 1. The feeders utilize the hay from their farms, alfalfa, clover, or timothy, together with bean fodder, if they have it, and mill feeds, with a relatively large part of the rations made up of corn and linseed-oil meal. Usually the corn is fed whole and the oil meal preferably in the form of the oil cake broken up into pieces a little larger than peas. * * *

The trouble appears suddenly and does its work quickly. It is sometimes accompanied by paralysis. It nearly always proves fatal, only about 1 or 2 per cent of those afflicted ever having been known to recover. The disease seems to occur only where lambs are being fed heavily, and it then attacks the strongest and most vigorous. * * *

While this disease has been prevalent for some years, its exact cause has not yet been determined. Two opinions have been set forward: First, that the disease is caused by feeding an excess of protein in the ration; second, that the disease is caused by overfeeding.

Investigations by the department of animal husbandry of Cornell University Experiment Station indicated that the trouble is caused mainly by sudden overfeeding rather than from feeding a narrow (high-protein) ration. The best results were obtained on rations with a relatively narrow nutritive ratio—that is, 1:5. It seemed to be clearly shown that in a fattening ration for lambs a relatively large amount of protein is necessary to keep the lambs up on the heavy grain ration required for the best results in fattening.

In the opinion of those who conducted the experiments on the subject there should not be the wholesale loss from overfeeding that some feeders have experienced if proper precautions are taken to keep the rack spaces all occupied and to distribute the grain equally, although there may be an occasional loss from the heavy feeding or loss from nervous excitement, which is thought to be one cause of apoplexy.

The ration giving best results was alfalfa hay in the morning, bean fodder at night, with a grain mixture for 25 lambs of 30 pounds corn, 30 pounds wheat salvage, and 15 pounds oil meal. From November 4, when the lambs were bought, until November 15 they were fed only hay. At this date they were started on a mixture of equal parts by measure of corn, oats, and wheat bran.

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[1] Compiled from New York Cornell Sta. Buls. 285 and 305.

On December 1 all three pens were consuming one-half pound of grain in two feeds and about 1¾ pounds of fodder per day per head. Care was taken to have the grain evenly distributed through the racks. As the amount of grain was increased the fodder was diminished, until it reached 65 pounds for 50 lambs per day, or 1.3 pounds per head, after which the amount of fodder was not changed throughout the remainder of the experiment. The lambs were purposely very closely confined as to rack space from the first. * * *

On December 25 the lambs were eating 1 pound of grain per head per day. The increase in grain was made very slowly and carefully, so as not to cause any trouble in digestion. On January 15 they were eating 1½ pounds of grain per lamb per day.

In later experiments it was shown "that succulence in the ration is very desirable and silage or roots should be fed if obtainable. * * * The most economical ration was that with a nutritive ratio of 1:5.3, with silage for succulence. This ration produced the largest gains at the lowest cost per pound of gain."

It therefore appears from these investigations that large losses in winter feeding may be avoided by gradually increasing the ration fed, which should contain some succulent material, and exercising great care to see that it is evenly distributed among the lambs, none getting more than its proper share. The latter is done in large measure by restricting the rack space to that actually necessary and evenly distributing the feed in the racks.

COST OF MARKET MILK.[1]

The increased price of labor and of feeding stuffs during the past decade has caused the dairyman to consider more carefully the actual cost of milk production in order to discover wherein his expenses may be reduced, as the advance in the price of milk has not kept pace with the increasing cost of production. One of the first steps to be taken in reducing the cost of producing milk is to dispose of the poorest cows in the herd, and these can be detected by keeping individual records of each cow. The importance of these records has been emphasized in previous issues of this series.[2] Another important step is to determine the actual cost of milk production after the poor milkers have been eliminated. This cost necessarily varies with the price of feeding stuffs, methods of management, and so many other factors that to determine the cost of producing milk with any degree of accuracy is not an easy matter. Many estimates have been published which are valueless because of the faulty methods of keeping farm accounts.

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[1] Compiled from Rpt. Sec. Agr. 1910, p. 20; Illinois Sta. Circ. 134; Massachusetts Sta. Rpt. 1910, pt. 2, p. 27; New Jersey Stas. Rpt. 1909, pp. 56–76; New York State Sta. Bul. 322; Canada Expt. Farms Rpts. 1910, p. 67; Report of the Commission on the Cost of Living. Boston: Govt., 1910, p. 316; Report of the Attorney General in the Matter of the Milk Investigation. Albany: Govt., 1910; U. S. Dept. Agr., Bur. Anim. Indus. Circ. 170.

[2] U. S. Dept. Agr., Farmers' Bul. 366, p. 20.

G. M. Whitaker, of the Dairy Division of this department, has discussed[1] the wide variation in statements of those milk producers who claim to keep systematic accounts, and pointed out that until producers improve their methods of bookkeeping the exact cost of producing milk will remain a debatable question.

In order to simplify methods of determining the value of individual cows, W. J. Fraser, of the Illinois Station, has prepared a table which is based on the findings of the department of dairy husbandry at that station for the past 15 years. By means of this table, and knowing the annual milk yield, the profit or loss of any cow can be easily estimated.

Economic conditions are not the same in different parts of the country, and while this table is made to apply especially to the Central West, it should be found applicable to the entire country. In the eastern part of the United States feed is higher, and it will cost more to keep a cow a year than in the Central West, but the value of the product is also greater, while in the West the cost of keep will be less than in Illinois, but the receipts for the product will also be less. For these reasons the application of the table should be a good guide in any part of the country, and its object accomplished, as it is designed to show, in the most striking manner possible, the difference between good and poor herds for the purpose of making money.

The price for the product is considered at the market value of butter fat at the creamery, and this price should be obtained by any dairyman in the State, no matter what his location. If the milk were shipped to a city for direct consumption, retailed directly to the consumer, or cream sold for a fancy trade, the returns would be much greater than indicated in the table.

The production per cow is the average for six years—the length of time cows are milked in most herds. Although some cows produce for twice this length of time, there are also many which drop out after only one or two years' production.

The value of the cows producing the different yields is estimated as nearly as possible at their actual market price. Cows producing 2,000 pounds of milk are valued at $30, and their value increases $5 for every additional thousand pounds produced up to 6,000 pounds; above this, $10 for every thousand pounds' increase in production.

The value of cows when disposed of is estimated at $30 for cows producing 2,000 pounds of milk, and this price decreases to $25 for cows giving 5,000 pounds of milk and above.

The amount of skim milk is figured as 85 per cent of the whole milk, as this is the amount returned from creameries or obtained from the hand separator on the farm.

Skim milk is valued at 20 cents per hundred pounds, since the best data show that it requires an average of 5 pounds of skim milk to equal 1 pound of grain in pork production. When grain is worth 1 cent a pound, or $1 per hundred pounds, skim milk would be worth 20 cents per hundred pounds. If the skim milk is fed to heifer calves of good quality, the value will vary from 20 cents to $1 per hundred pounds, depending upon the conditions and the quality of the calves.

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[1] Hoard's Dairyman, 41 (1910), No. 50, p. 1478.

Calves from cows producing less than 5,000 pounds of milk annually are considered at veal prices only, and are valued at $3 when 5 days old, when the milk of the dam is fit for use. From cows producing more than 5,000 pounds of milk annually the value of the heifer calves increases more rapidly, as the dams are more efficient producers. Bull calves are not considered of value except for veal, unless they are from cows producing an average of 10,000 pounds of milk annually, in which case their value is placed at $16, and this value increases at the same rate as the heifers from higher producing dams. The question may rightly be raised if bulls from grade cows should be used for service. It would be better not to do so, unless it is known that the dams were, for at least two generations, good producers, but at the present stage of dairy cattle breeding in the United States, bull calves from cows producing an average of 10,000 pounds of milk for six years would be of service in increasing the production of our future dairy cows. In fact, it is by this method that the dairy cattle of Denmark have been so markedly improved in the last 25 years.

The manure is figured at 11 tons per head for cows producing 8,000 pounds of milk. On the 20-acre dairy farm at the university last year cows which were kept in the barn during the winter and in a dry lot during the summer produced 13 tons of manure per cow. The average value is considered at $1.50 per ton. At the Illinois Agricultural Experiment Station, on a three-year rotation of corn, oats, and clover, manure has increased the crop yield $1.60 for each ton of manure used, figuring the market value of the crops, for the first three years after it is applied. No consideration is taken of the increased production from the effects of the manure after the first three years. At the Ohio Experiment Station the value of the crop yields has been increased $2.34 for each ton of manure used. From the figures above stated, $1.50 a ton is a conservative value on cow manure which has been well cared for. Cows which produce less than 8,000 pounds of milk will produce, on the average, less than 11 tons of manure. Cows producing more than 8,000 pounds of milk will not only produce more manure, but it will be of a better quality, owing to the fact that they are fed more concentrates. For these reasons the value of the manure is lowered 50 cents per cow for every 1,000 pounds' decrease in production of milk below 8,000 pounds, and raised 50 cents per 1,000 pounds' increase in production above 8,000 pounds.

The labor per cow at the dairy of the University of Illinois has amounted to $22, where the cows were stabled continuously throughout the year. This is more, decidedly, than it will cost under the ordinary farmer's conditions; hence $20 is taken as a basis for labor on cows producing 8,000 pounds of milk annually. The labor for cows producing less than 8,000 pounds of milk will not depreciate materially, as feeding, watering, cleaning stables, and caring for the individual cows will be practically the same, regardless of their production, and cows giving less milk will be much slower milkers, thus requiring more time per pound of milk obtained. The labor is reduced only 50 cents for every thousand pounds decrease in milk production below 8,000 pounds, making a minimum cost on a cow producing 2,000 pounds of milk, $17. With increased production, only a small amount of extra labor is required in caring for the cows, and as large producers give down their milk more freely, less time is consumed per pound of milk in milking, and $1 is added to the cost of labor for each 1,000 pounds increase in yield.[1]

The average barn for a herd of 40 cows is worth $2,000, or $50 per cow. The interest on this, per cow, would amount to $2.50 a year, and taxes, insurance, repairs, and depreciation will amount to $1.50 a year, making a total cost per cow for buildings and their maintenance, of $4 per year.

The total annual expense of keeping a good pure-bred sire, including feed, care, and depreciation, is $75. In a herd of 40 cows, $2 per cow must be allowed annually to have each calf sired by a pure bred. Since this amount is so small, every dairyman should keep a good pure-bred sire, even though he has but a small number of good cows in his herd.

On the average, cows will be kept in dairy herds for six years, therefore the annual depreciation on the cow is figured as one-sixth of the difference between the value at the time of first freshening and the value when disposed of. To this must be added the interest on the value of the cow each year.

Spraying materials, medicine, and veterinary service are estimated at 10 cents per 1,000 pounds of milk produced. While the relative increase is rapid, it is true that the large producers are the ones requiring more medical attention, and cows producing only 2,000 or 3,000 pounds of milk in a year need little, if any, of this expenditure.

The expense for dairy utensils, if the milk is taken to a condensing factory, bottling plant, or creamery, should be about 90 cents for a cow producing 8,000 pounds of milk. If the milk is separated on the farm, fewer cans are required and less expense is involved in hauling the milk, but, to offset this, there is an additional outlay for a cream separator. If milk is shipped to a large city it is necessary to have five sets of cans, which, being badly handled and frequently lost, makes the expense for cans heavy. However, as the milk is sold by measure, it has been found by actual practice that the denting of the cans soon makes them hold enough less milk to compensate for the wear, tear, and loss on cans. Since the cost of utensils will depend somewhat upon the amount of milk handled, an allowance of 5 cents per 1,000 pounds of milk produced is made. * * * It can be seen that in the case of the cows producing less than 9,000 pounds of milk, the skim milk, calf, and manure do not pay for the labor, housing, service fee, and depreciation on cows and utensils, while with cows producing more than this amount, these returns are so much greater that there is a rapid rise in profit as the production increases.

To obtain the final results of profit or loss per cow, the milk, to be as near the average for all breeds as possible, is considered to contain 4 per cent butter fat, which is the average of the 1,200 cows tested by this station. In applying the table to a herd, computations for each individual cow must be made, depending upon the total amount of butter fat in her milk.

The value of the butter fat is based upon the Elgin prices for butter during the years 1907 and 1908, which averaged slightly above 27 cents. The overrun, which is the amount of butter made above the amount of butter fat, is allowed for the expense of making the butter.

The cost of feed per cow is based on the prices of feed for the past two years, which is decidedly higher than formerly. The cost of feed is raised $2 for each 1,000 pounds increase in production of milk. This increase is based upon a large number of yearly records kept at the University of Illinois, where an accurate account is kept of all feed consumed and milk and butter fat produced for the entire year, on cows that vary in production from 2,000 to 15,000 pounds of milk annually. Too much emphasis can not be placed upon the fact that the milk is made more economically by the higher producers, as they are far more efficient cows.

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[1] No account is here taken of the cost of superintendence, but only of unskilled labor at ordinary prices.

The table may safely be used as an index to the profits, because under existing conditions nearly all herds contain individual cows of vastly different production. On the majority of dairy farms in the intensive dairy region of Illinois, all cows in milk are fed practically alike as to grain, regardless of their production, and their being in the same herd, the cost of all items for the different cows will be nearly the same. Under these conditions the actual difference in profit between the good and poor cows will be even greater than the table indicates.

These figures are based upon definite data worked out at the experiment station, but the result will fluctuate slightly, according to the way the herds are fed. The price of feed varies in different years, but as a rule the price of the product varies with the feed, so that this fluctuation is small. When a dairyman uses this table, the question is not whether the results obtained are absolutely correct to a few cents, as it makes no special difference to a farmer whether a cow brought in a profit of $10 or $10.50, but it does make an enormous difference whether she lost him $5, or made him $20, as may be easily done by ordinary cows producing within the range of many cows in the average herd.

Until a more uniform system of keeping dairy accounts is adopted the cost of production as determined by different individuals is hardly comparable, but in the absence of the ideal scheme it is thought desirable to cite a few estimates that have been made by several stations and by private individuals on the cost of production, as they point out the necessity for more accurate figures in this connection. In addition a few figures are given on the cost of bottling, railway transportation, and delivery by the retailer.

At the New Jersey Station the average cost of feed per quart of milk was 3.04 cents, and the total cost of milk, including labor, was 4.16 cents per quart, when the figures were based on the cost of growing the feed consumed. When the cost per quart was based on the market price of feed, the total cost was 4.8 cents per quart.

At the New York Geneva Station the cost of milk per pound[1] was found to range with different cows in 1906 from 0.48 to 1.34 cents; in 1907, from 0.6 to 1.578 cents, and in 1908, from 0.655 to 1.838 cents.

At the Canadian Experimental Farms, in a herd of 49 cows the cost ranged from 52.2 cents to $1.67 per 100 pounds. At the Massachusetts Station the average yield per cow in 1907 was 5,874.4 pounds of milk. The food cost per cow was $78.19, and the food cost of a quart of milk was between 3 and 3.2 cents. In 1908 the yield per cow was 5,639.5 pounds of milk and the food cost $82.21 per cow, making the food cost per quart of milk 3.3 cents. If other items of cost had been added to the food cost, it is estimated that the total cost of producing milk satisfactory in sanitary quality and containing from 4 to 5 per cent of butter fat would have amounted to 4 or 5 cents per quart. It is stated that milk produced under more than average sanitary conditions would naturally cost considerably more than the figures presented in these estimates.

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[1] A quart of milk weighs 2.15 pounds.

Mr. Whitaker estimates that in determining the extra cost of producing clean milk in a 15-cow dairy there will be an added expense of 5 cents per cow per day for labor plus 5.5 cents for new or additional equipment in extreme cases. To this should be added 5 cents more to remunerate the proprietor for his extra care and vigilance, making an extreme increase of 15.5 cents per cow per day. As the product of a cow ranges from 4,000 to 10,000 pounds of milk per year, or from 5 to 12 quarts a day, the added expense for labor would amount to from one-half to 1 cent a quart; and in rare instances, where great additional expense is required for repairs, new construction and new equipment, these might raise the increase 1 or even 2 cents a quart more. It is thought, however, that this added expense of improved methods and equipment would be partly offset by increased production and increased economy of feed, so that the net extra expense of producing clean milk would probably be somewhat less than the figures given. Reasonably clean milk is worth 2 cents more than common, slovenly milk. The former is safer and, therefore, cheaper at the increased price, whereas dirty milk ought not to be considered a merchantable article at any price, no matter how low. Prof. Heinemann estimates that a sanitary milk containing not more than 1,000 to 2,000 bacteria per cubic centimeter even when delivered for consumption 100 miles away can be produced, bottled, and sold at a profit for 6 cents per quart in a plant where the output is 250 quarts per day.

Prof. Sanborn[1] states that on his farm in New Hampshire it cost $121.67 to produce 6,000 pounds of milk. Mr. E. D. Howe, a Massachusetts farmer,[2] states that it cost over 6 cents per quart to produce the milk and 2.7 cents per quart for delivery. These figures are given for ordinary milk. Mr. B. W. Potter[3] states that the cost of producing a quart of ordinary milk is 5 cents, and certified milk 10 cents per quart. Mr. J. B. Greer[4] estimates that the cost of producing milk on a 160-acre farm near Elgin, Ill., was about 2.43 cents per pound. The average cost of producing milk in 1908 and 1909, as testified to by producers at the investigation of the New York State attorney, was 3.513 cents per quart. A New York dealer in milk testified that the freight, bottling, carting, and delivery amounted to 5 cents per quart. W. A. Graustein, of the Boston Dairy Co., submitted figures to the Massachusetts Cost of Living Commission showing that the cost of handling and delivering a quart of milk at retail from the time it enters the bottling room in Boston until it reaches the consumer is 3.2 cents. This would make the cost of a quart of milk 8.3 cents, distributed as follows: Paid to the farmer 4.41 cents, cost of transportation 0.69 cent, delivery to the consumer 3.2 cents. These figures include nothing for profit, interest, supervision, or losses. Other dealers stated that this total is too low and that milk can not be delivered for less than 3.7 cents per quart.

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[1] New England Farmer, 89 (1910), No. 48, p. 5.
[2] Rural New Yorker, 69 (1910), No. 4078, p. 1187.
[3] Country Gent., 75 (1910), No. 2985, p. 379.
[4] Prairie Farmer, 84 (1910), No. 20, p. 8.

The Secretary of Agriculture reports as follows concerning the investigation of prices of transporting and delivering city milk supply:

> While it is true that the dairyman is receiving considerably more for his milk than he did before the present era of high prices, yet it was discovered in this investigation that throughout the United States he receives a scant 50 per cent, or one half, of the price paid by the consumer. The other half goes to the railway company for carriage, to the wholesale milk dealer, if there is one in the chain of distribution, and to the retailer who delivers at the consumer's door.
>
> Freight charges for carrying milk vary according to distance, but their average may be regarded as approximately about 7 per cent of the consumer's price. With the farmer receiving about 50 per cent of that price and the railroads 7 per cent, the remaining 43 per cent of the consumer's price is received mostly by the retailer.
>
> The milk wagon of the retailer has a long route. It stops at a house or two in one city block, perhaps passes several blocks without stopping, and so proceeds to serve customers thinly distributed along a route of miles. At the same time the milk wagons of other retailers are covering various portions of the same route, and so there is great waste of effort and of expense in the distribution.
>
> The division of States in which the cost of distributing milk from producer to consumer is the most in the North Central group, in which producers receive 44 per cent of the prices paid by the consumer. Next in order follow the Western States with 47 per cent, the North Atlantic States with 53 per cent, the South Central States with 55 per cent, and the South Atlantic States with 57 per cent.
>
> The average price paid by consumers in the 78 cities is almost exactly 8 cents per quart. In the North Atlantic and North Central States the average is 7.5 cents; in the Western States, 8.9 cents; in the South Central, 9.1 cents; and in the South Atlantic States, 9.3 cents. These prices are for the last week in June, 1910.

PROPAGATION OF STARTERS FOR BUTTER MAKING AND CHEESE MAKING.[1]

E. S. Guthrie, of the New York Cornell Station, gives the following brief directions for propagating a starter "containing desirable bacteria for the ripening or souring of dairy products":

1. Take three 1-quart milk bottles or fruit jars.[2] Glass is preferable, as it allows the operator to see when all of the dirt has been removed, and the condition of the curd can easily be inspected through the transparent wall. Three bottles should be employed, for in heating glass is likely to break; and it is always well to have a sufficient number of containers from which to choose.

2. Use fresh, clean milk, which must have a nice flavor. It may be either whole milk or skimmed milk. Usually it is advisable to use whole milk, for it is easier to choose desirable samples before milk has passed through the separator than afterwards.

3. Fill the containers one-half to two-thirds full of milk. If they are filled full, it is difficult to prevent contamination from the covers, which are hard to sterilize when the pasteurization is done in hot water.

4. Protect the containers with regular covers (caps or tops). Hastings, of Wisconsin, recommends the use of glass tumblers for covers.

5. Pasteurize by heating to 180° to 200° F. for 30 minutes[3] or longer and then cool to ripening temperature of 60° to 75° F. Pasteurization may be accomplished by tying a string about the necks of the bottles and suspending them in a pail or vat heated by steam or in a kettle or dish heated on a stove. (If pasteurized over a fire, do not let bottles rest on the bottom of receptacle.) Other supports may be used to keep the containers from tipping over. The temperature should be raised and reduced slowly to prevent breaking the glass.

6. After pasteurization the milk is ready for inoculation. Inoculate in a quiet place where the wind can not blow dirt and bacteria into this clean seed bed. With dry fingers remove the cover and place it in a bacterially clean spot, as in a recently scalded dipper. Pour in all of the commercial culture or 2 to 10 per cent from the previous day's culture.[4] Be sure that the curd from the previous day is well broken. After inoculation, shake the freshly inoculated sample to distribute the bacteria.

7. Incubate at about 60° to 75° F. The first inoculation from the commercial culture should be incubated at about 70° to 85° F. The small inoculations require higher temperatures than the large inoculations. By experience an operator can soon learn what inoculation and temperature to use to ripen his starter

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[1] Compiled from New York Cornell Sta. Circ. 10.

[2] Larger receptacles may be used. Often 2-quart bottles or jars are used.

[3] Bouska, formerly of Iowa, says: "A temperature of 150° F. kills all sporeless bacteria. Higher temperatures up to 212° F. do not kill the spores, but they are so weakened by the higher heat that they germinate more slowly and their harmful effect is retarded. This fact and the results of experience indicate a temperature of about 185° F. to 200° F. as best. The heating and cooling can be done in cans immersed in water. Stirring hastens the processes, but is not necessary when the heating surface is not hotter than about 200° F. Where the heating is done by steam, stirring is necessary to prevent scorching."

[4] The amount of ripened starter for inoculation can be measured accurately in a vessel, as a sterilized cup or spoon, or it can be determined rather closely by the eye. Place the thumb above the milk line in the bottle to be inoculated, in this way measuring the amount to add, and raise the milk line to that mark by pouring in the ripened starter.

in a given time. Usually a 6 per cent to 8 per cent inoculation will ripen a starter in 12 hours at about 65° F. The temperature must be fairly constant.[1]

8. The starter is ripe when a curd forms. This curd should be soft and like custard in appearance. It should not be hard and firm.

9. After the starter is ripe, hold it at 50° F. or a few degrees lower until time to use. For best results a starter should not be held longer than a few hours. However, it may be held two or three days and not be badly overripened. Do not shake the starter before putting it in storage.

10. Upon examination the curd should be smooth and compact, without gas pockets. Gas shows the presence of undesirable bacteria. A hard, lumpy curd, whey, and high acid show the overripe condition, which is very undesirable. After the condition of the curd is noted, shake well to break it into a smooth, lumpless condition. Shake with a rotary motion, being careful not to touch the cap for fear of contamination. Now smell and taste it, but never from the starter container. Always pour some of the curd into a spoon or cup, and then replace the cover immediately. After smelling, it is best to put at least a teaspoonful into the mouth. Seek for a desirable, clean, mild, acid flavor. The first propagation is likely to be somewhat disagreeable, because of the presence of some of the original medium.

In a creamery or a large dairy it is necessary to carry more than a pint or a quart of starter. Along with the mother starter a second starter of 10 to 50 pounds may be carried. After the mother starter in the glass container is inoculated, the remainder of the previous day's mother starter is poured into the second starter, and the cream is inoculated from the second starter. In large creameries third and fourth starters are carried. Care should be taken in pasteurization not to cook the milk in these large amounts. In the mother starter this makes little difference.

It is necessary to use a larger inoculation from starter to cream than from starter to starter, because the seed bed is not so well prepared. The inoculation of the cream may vary from 8 per cent to 50 per cent.

Usually it is necessary to propagate the mother starter two or three times before the flavor of the commercial culture, which is often very disagreeable, will disappear.

A starter may be carried two to four weeks before it goes "off." Often it is carried several months, and often less than two weeks. This depends almost altogether on the carefulness of the operator.

On the farm the cream might be handled in this way: Suppose the dairyman separates each half day 10 pounds of cream testing about 35 per cent butter fat. On Monday a new starter of about two-thirds of a quart is inoculated from a starter that has been held from Friday or Saturday. The remainder of the held-over starter is put in the 10 pounds of cream. The cream is then set at about 65° F. It may have to be set in a cooler place before evening. In the evening 10 pounds more cream are added and all the cream, which is now in the one vessel, is set at about 60° F. On Tuesday morning add the morning's cream and set at 60° to 65° F., as during the day it is more convenient to watch the ripening process than at night. In the evening add the evening's cream and set at 58° to 60° F., for by this time there is a very large army of bacteria at work. On Wednesday morning churn the 40 pounds of cream and start the ripening process over again with Wednesday's cream.

It is important not to develop too much acid. The amount of inoculation and the temperature must be managed to gain a certain end under certain conditions.

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[1] An incubator should be insulated as is a refrigerator or a fireless cooker.

THE PLASTERED SILO.[1]

H. E. McNatt, of the Missouri station, states that one of the most successful types of silos is that generally known as the "plastered" or Gurler silo. This type is especially adapted to regions where lumber is comparatively cheap. The advantages of this silo are that (1) it can be built entirely from ordinary lumber; (2) it requires no highly skilled labor for its construction; (3) it preserves the silage as well as any type of silo in use; and (4) it is strong and durable when properly made.

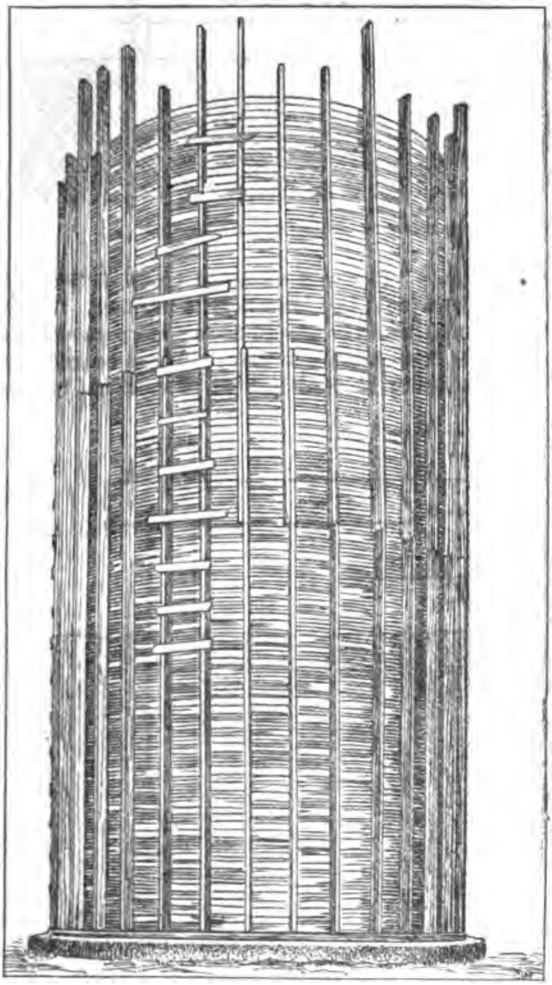

FIG. 1.—A plastered silo complete, except siding and roof.

It is built much like a frame house, except that it is round in form, with a lining of boards running lengthwise around it, somewhat like the hoops of a barrel, which give it strength to resist the immense pressure of the silage. (Fig. 1.) Its cement plastered wall protects the wood framework from decay.

It is not advisable to have the silo more than 16 feet in diameter. "The best proportions are height about twice the inside diameter." The silo is constructed as follows:

A short stake is driven firmly into the ground at the point selected for the center of the silo. To the top of this is secured, with a single nail, a horizontal piece of light, stiff lumber, bearing upon one end an arm sharpened so as to scratch a circle on the ground when moved around the center post. (Fig. 2.)

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[1] Compiled from Missouri Sta. Circ. 48.

This circle marks the outside limit of the silo foundation and care should be taken to get the measurements correct.

With the circle as a guide a pit is dug to a depth of from 2 to 3 feet. The wall of dirt is cut plumb and the floor leveled.

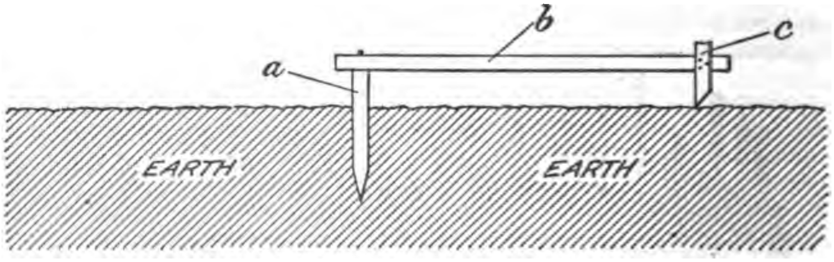

FIG. 2.—Arrangement for marking out circle for foundation.

The foundation is reenforced concrete. Figure 3 shows in cross section the construction of one of the frames, which hold the form boards in place. These frames, which are made of 1 by 4 plank, should be placed 30 inches apart around the pit to hold the inside and outside form boards in place. These boards are half-inch lumber of 4-inch width, so as to be readily bent to conform to the wall of the pit. The distance between the inside form boards and the pit wall should be 1 foot. The concrete foundation should extend about 1 foot above ground on the outside. Figure 3 also shows how the upper corners of the concrete wall are beveled after the concrete has become sufficiently stiff to permit of this being done. The 2 by 4 sill with a large spike for an anchor is also

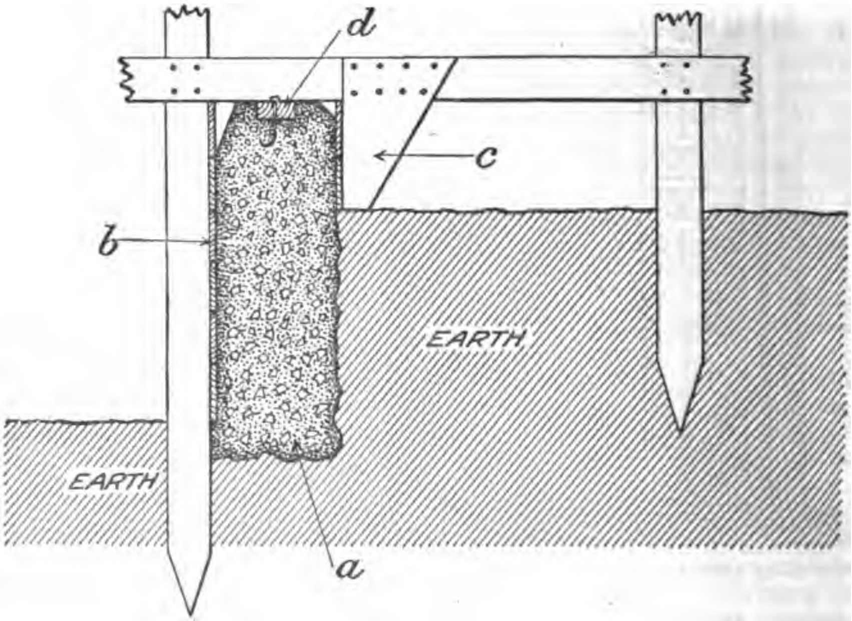

FIG. 3.—Cross section of frame holding form boards in place.

shown embedded in the top of the wall. The concrete should be made from clean, sharp sand and enough Portland cement to insure a strong mixture. The proportions will run about as follows: 1 part cement, 2½ parts sand, and 5 parts of broken stone. Enough water is added during the mixing, which must be thoroughly done, to make a mixture that is thin enough to settle to the form with light tamping, but not so thin as to carry the cement out through the cracks of the form by the water leaking out. The foundation is reenforced with a piece of 3-foot woven wire fencing placed in the center of the form before filling with the concrete mixture.

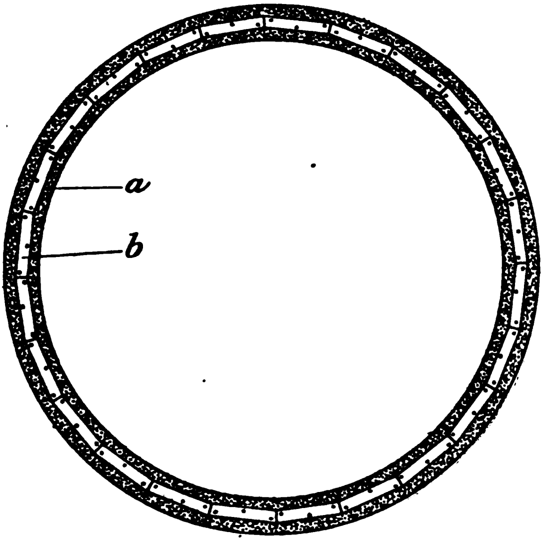

FIG. 4.—View of foundation from above, showing sill.

After the wall has set sufficiently to stand alone, the forms may be removed and the floor laid to a depth of 4 inches. It is advisable but not absolutely necessary to pack about 4 inches of wet cinders in the bottom of the pit before laying the floor. Before the wall and floor have hardened, a finishing coat of sand and cement mixed 3 to 1 should be put on with a plasterer's trowel.

Figure 4 shows a view of the top of the foundation wall with the sill in place. The sill is made of 2 by 4 lumber cut into 2-foot lengths. Each piece is put in place while the concrete is soft and anchored by 3 heavy spike nails with turned points, or thin bolts with nuts and washers on their ends. This anchoring is necessary, and ties the woodwork of the silo firmly to the concrete.

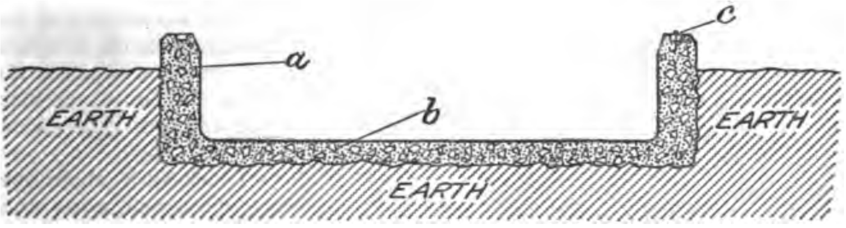

FIG. 5.—Vertical section of foundation wall, showing sill.

Figure 5 shows a vertical section of the foundation wall and floor as it appears when complete.

The studs are made of 2 lengths of 2 by 4 lumber spiked together at the middle and are erected 2 feet apart. If the diameter and height of the silo are more than about 16 feet by 32 feet, it is advisable to either use 2 by 6 lumber or set the studding only 18 inches apart. Two pieces of 2 by 4 lumber spiked together to make a 4 by 4 is used as a center pole to tie the studding to while they are being set up. Each separate stud is toenailed to the center of a section of the sill. Only the lower half of the studding is put up first, the second piece being spiked on after the lower half of the silo is nearly complete and needs no bracing. The studding is plumbed with a carpenter's level and tied in position temporarily with small scraps of old lumber.

When the lower half of the studding has been tied in position, the sheeting, which is one-half inch lumber made by ripping 1 by 4 or 1 by 6 lumber, is nailed horizontally on the inside of the studding, taking care to break joints. The sheeting should be nailed on from the foundation to within about a yard of the top of the studding and then the lath put on.

Although somewhat expensive, the sheet steel or expanded steel lathing found on the market is the best for the purpose. But ordinarily the same material as the sheeting ripped into inch and one-half widths and beveled on the edges is used. These are nailed on top of the sheeting, so as to break joints, covering cracks whenever possible and leaving a suitable space for clinching the mortar.

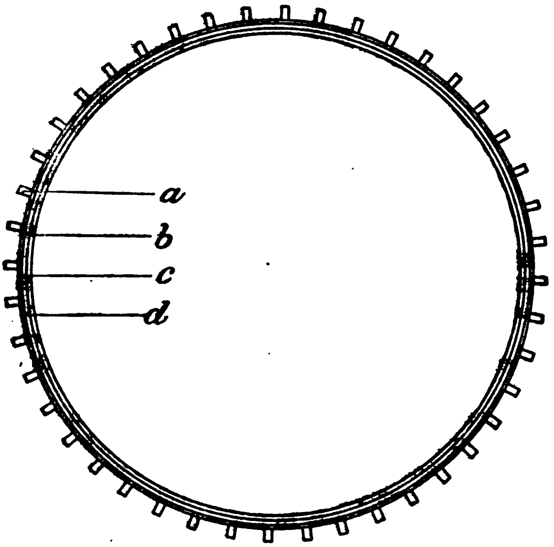

FIG. 6.—Cross section of silo, showing arrangement of studding and three inner layers.

When the sheeting and lath have been put on to within about a yard of the top of the first length of studding, a temporary platform or trestle may be laid to enable the workmen to erect the second half in the same manner as the first was put up. It is well to leave the center pole resting on the concrete floor and extend it by adding another piece.

The second half of the studding should be spiked to the first with a lap of about 2 feet. After plumbing and tying in place, the sheeting and lath are put on, and finally, after removing the temporary platform, the middle is completed by putting on the sheeting and lath. Care must be taken that no wide cracks are left.

The wall of the silo is plastered to a depth of about 1 inch—i. e., about one-half inch over the lath—with a rich, well-mixed mortar or concrete, made from 3 parts of sharp, clean, coarse sand or finely crushed stone and 1 part of good Portland cement. This mortar should be about as thick as that ordinarily used in plastering a house.

Figure 6 shows in diagram a cross section of the silo as it has been described thus far. Three inside layers are seen. The innermost is the plastering, the next is the lath, and the one lying against the inside edges of the studding is the sheeting.

Figure 7 shows a small part of the same cross section more in detail.

Figure 8 shows a longitudinal section taken down the side of one of the studs, showing the cement plaster, the lath, and the lining.

Four doors are sufficient for a 30-foot silo, and five are enough for a 36-foot silo. Ordinarily the bottom of the first door will come about 2½ feet above the sill. The doors are 2½ feet high, and 4 feet are allowed between doors.

When the studding is being spliced for the erection of the upper half of the silo, care must be taken that the studding between which the doors are to come are not lapped, but are put end to end and tied together with a 6-foot piece of 2 by 4 spiked to each at the junction. This allows a door jamb which is simply another 2 by 4 set back from the inside edge of the stud an inch and a half and either well spiked or bolted in place. Figure 9 shows this region, including the door in place, in cross section. The upper and lower jambs of the door are made from short lengths of 2 by 4 spiked across at the proper places.

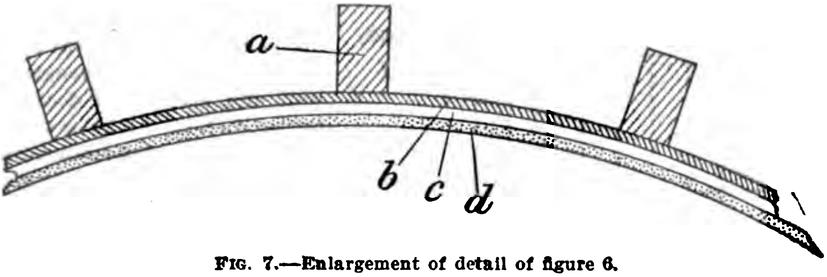

FIG. 7.—Enlargement of detail of figure 6.

The doors themselves are made from flooring boards nailed and screwed together at right angles, with a sheet or two of tar paper between. This construction is illustrated in figure 9.

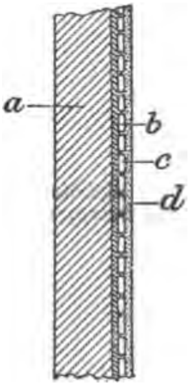

FIG. 8.—Vertical section down side of one of the studs.

In fitting the doors before filling the silo, a layer of tar paper or heavy building paper should be put between the jambs and the doors. The doors are held in place by heavy bolts, fitted with large nuts and washers, passing through them and through pieces of 2 by 6's laid across the opening on the outside of the silo. Two crosspieces are needed; one near the bottom, the other near the top of the door.

When this point in the construction of the silo is reached, although not completed, it may be filled if it is necessary to do so. Figure 1 on page 19 shows such a silo which has been filled and emptied once. Its general appearance, strength, and resistance to weathering, may be improved, however, by putting on a roof and some weatherboarding or siding.

Although somewhat expensive, galvanized sheet metal makes a good siding. Probably the most practical plan, however, is to put on some hoops and nail ordinary boxing lumber to them. The hoops are made of three thicknesses of the sheeting lumber put around the outside of the silo every 4 feet, being careful not to cross doors. One thickness is put on at a time. The joints must break to insure strength. The boxing lumber is put on vertically and nailed to the hoops. The cracks are covered with ordinary weather strip.

A plate similar to the lower sill is put around the top of the silo on top of the studding. The roof is usually made in the same manner as the roof of a house, except the rafters are put up in conical form, and no joists are put in. The roof boards are put on in short lengths, and shingles or some other good roofing material put on top. A properly made door must be left in the roof through which to fill the silo.

When the silo is covered on the outside in any way other than with hoops and vertical boxing, it is necessary to bore a large auger hole between each stud on the outside at the bottom and on the inside at the top so as to allow the air to circulate through the wall and keep down decay of the woodwork. All holes should be covered with fine-mesh woven wire to keep rats and mice out.

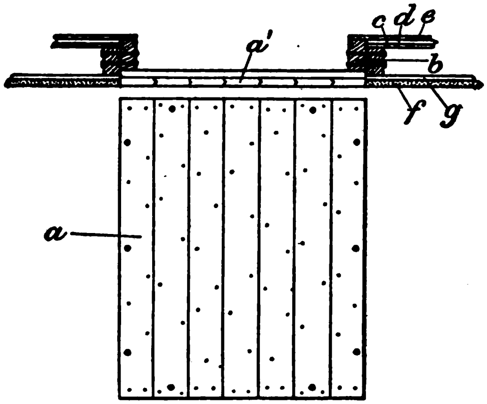

FIG. 9.—Detail of door and jamb.

When hoops and vertical boxing are used, a few large sawed holes about 4 by 6 inches in size at the bottom and top will serve, since the air can readily pass between the boxing and the studding.

It is necessary to anchor the silo firmly with three or four strong guy wires or cables of short length. These are very valuable in case of windstorms. They are attached to sleepers buried several feet in the ground about 4 or 5 feet out from the base of the silo, and run to a point on the studding about halfway to the top of the silo, where they are firmly secured.

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FARMERS' BULLETIN 470.

GAME LAWS FOR 1911.

A SUMMARY OF THE PROVISIONS RELATING TO SEASONS, SHIPMENTS, SALE, LIMITS, AND LICENSES.

BY

HENRY OLDYS, C. E. BREWSTER,
AND FRANK L. EARNSHAW,
Assistants, Biological Survey.

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1911.

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U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., July 29, 1911.

Sir: I have the honor to transmit herewith, for publication in the series of Farmers' Bulletins, a summary of the game laws for 1911 relating to seasons, shipment, sale, limits, and licenses, prepared by Henry Oldys, C. E. Brewster, and Frank L. Earnshaw, of the Biological Survey. This bulletin is similar in scope to those issued annually since 1902 and includes changes in the laws made during the present year. In the section relating to the legislation of the year a brief but comprehensive review is given of the new laws, a feature believed to be of special value to those interested in game protection.

Respectfully,

Henry W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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GAME LAWS FOR 1911.

INTRODUCTION.

SCOPE OF THE BULLETIN.

The present bulletin, containing the twelfth annual summary of the game laws of the United States and Canada, has been prepared on the same general plan as those issued each year since 1902. It differs from other publications on the game laws in several important points: (1) Inclusion of a brief but comprehensive review of the measures enacted, (2) arrangement of provisions by subjects instead of by States, and (3) adoption of a uniform statement and order of the various details to facilitate ready comparison of similar provisions in different States. Its chief objects are to present in convenient form the restrictions on hunting which affect the enforcement of the Federal statute regulating interstate commerce in game, and to show the trend and general condition of legislation from year to year. Provisions relating to seasons, shipment, sale, limits, and licenses are included, but those relating to methods of capture, game refuges, enforcement of laws, disposition of fines and fees, and matters of special or local application are omitted. These can be found only by reference to the laws themselves or to the pamphlet editions of the game laws, obtainable in most States from the proper officials.[1]

With the rapidly growing complexity of regulations—Federal, State, and local—in 50 States and Territories, and the constantly increasing number of persons who hunt, the demand for information concerning game laws is spreading. The problem of how to keep the public informed of the numerous yearly changes taxes the ingenuity of officials, and can be solved only by the fullest cooperation on the part of the press, private associations, and individuals.

LEGISLATION IN 1911.

The game legislation of 1911, while it exceeded in volume that of any previous year, was rather directed to changes in the warden service, control of the license funds, and curtailment of the bag limits than to modifying seasons. Regular sessions were held in all the States but seven, and laws affecting the protection of game were passed in all except Nevada.[1] In Canada game laws were passed by Manitoba, New Brunswick, Newfoundland, Ontario, and Quebec; several orders in council were issued by British Columbia and Ontario, and one regulation by the surveyor general in New Brunswick. The total number of new laws was about 260.

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[1] A directory of these officers with their addresses is published as Circular No. 83, Biological Survey, U. S. Department of Agriculture, 1911.

Notable modifications were made in enforcement provisions. Five States—Delaware, New York, North Dakota, Oregon, and Wyoming—reorganized their warden systems, while nine others increased the warden force or otherwise strengthened it. Important, also, was the action of California under the constitutional amendment adopted in 1902 in dividing the State into six fish and game districts and providing separate seasons for each. A decided step forward was made in the creation of State game preserves. Manitoba established four, Montana three, North Dakota two, and Idaho, Washington, and Newfoundland one each, while Massachusetts, Oregon, and Pennsylvania arranged for the creation of future preserves without necessity for further legislative action.

The difficulties arising from unregulated control of the large funds derived from sale of licenses were reflected in the action of several States in diverting the whole or part of such funds to the State revenue fund and making appropriations for game protection. In Illinois [2] and Wisconsin the whole fund was thus diverted; in Missouri $30,000 was transferred to the general fund, and in Wyoming certain expenses of game protection were made chargeable directly to the general fund.

Measures looking to the increase of game by propagation or purchase were adopted by Massachusetts, New Jersey, Indiana and Wyoming, and the wisdom of permitting the possession and disposal of game reared in private preserves under suitable regulations was recognized by legislation in California, Maine, Massachusetts, Michigan, Missouri, New Jersey, and Wisconsin. In this connection it is of interest to note that North Carolina, one of the few remaining States allowing the export of live quail for restocking purposes, passed a law cutting off this privilege. The marketing of dead game was still further restricted through the adoption by New York of a measure closing its markets to all but a few foreign species and game raised in captivity, the most important step taken in this direction since Missouri by similar laws passed in 1905 and 1909 closed the markets of St. Louis and Kansas City.

Among the items of less general interest were the passage of doe laws in Vermont and Washington, the renewal of protection of antelope in Arizona by a Federal act, the absolute protection given all big game except deer in South Dakota, provision for the codification of the New York game law in January, 1912 (by a provision in the conservation act), the cutting off of sale of quail and robins in Tennessee, and the opening of a prairie chicken season in Illinois for the first time since 1903.

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[1] The laws of Arkansas, Georgia, Pennsylvania, Alberta, and Prince Edward Island have not been examined.

[2] The attorney general of Illinois rendered an opinion that the law establishing a game fund was unconstitutional.

Among the novel features of the year's legislation were prohibition of the use of dogs wearing bells or other noise-producing devices in wild-fowl shooting in Delaware, of automobiles in duck hunting in North Dakota, and of guinea pigs in hunting rabbits in Michigan; the establishment by Michigan of a 25-day deer license with a 45-day season; the disbarment of claims for damage to crops by deer by owner of lands posted against deer hunting in Vermont; the provision by Missouri that the appropriations for game protection should not be disbursed by the present State game commissioner (a legislative act promptly declared unconstitutional by the supreme court of the State); and a measure by Maine authorizing the export of game for advertising purposes.

There was little retrograde legislation; the abolition of the resident license in West Virginia, of the alien license in Vermont, and of all hunting licenses, and with them all means of supporting the warden service, in Delaware, partial opening up of spring shooting of shore birds in California, removal of absolute protection from deer in several counties of Michigan (probably unintentional), and repeal of the doe law in South Carolina were the most important acts opposed to the interests of the preservation of game. In this connection mention might also be made of the action of New Hampshire in prohibiting all scientific collecting of birds in the State.

Open seasons.—Many important modifications in seasons were made, the general tendency being toward further restriction. Absolute protection was given to elk and sheep in South Dakota; to elk in British Columbia; to deer and elk in seven counties in Idaho, and all big game in four other counties of the State; to deer in five counties of Oklahoma; and to sheep in several districts of British Columbia. The deer season was shortened from 11 days to 6 in Colorado and from 109 to 62 in California, but was lengthened in Michigan, South Carolina, Vermont, and Wyoming—in the latter State the season for elk and sheep was also extended. Vermont made provision for the reopening of the deer season in case the governor should exercise his authority to suspend it during drought. Many changes were made in the seasons for small game. Cottontail and bush rabbits were put on the game list and provided with a season in California. Wood ducks were added to the list by Delaware and South Carolina. Delaware also placed woodcock on the game list; Kansas, fox squirrels and snipe; Maine, eider ducks; Nebraska, killdeers and doves; and New Jersey, Hungarian partridges-

Absolute protection was given to gray and black squirrels by Kansas, wild turkeys by Massachusetts, wood ducks by Maine and Vermont, sheldrakes (on fresh water) by New Hampshire, upland plover by New Jersey, doves and swans by North Dakota, and Chinese pheasants by Oregon. Spring shooting was abolished by Maine in the case of shore birds; by Michigan as to snipe, geese, and brant; and by Oregon as to geese and swans in nine counties. Rhode Island shortened its shore-bird season to open October 15 instead of July 15. Michigan made its seasons for ruffed grouse and spruce hens uniform throughout the State; and New Jersey established uniform seasons for all upland game except woodcock. On the other hand, Michigan opened a season for quail, and Newfoundland abolished its closed season for shooting rabbits, leaving only a trapping season. Colorado, while lengthening the season for certain species of grouse from 3 weeks to 8, shortened the shore-bird and waterfowl season from 7 months to 5.

Export and sale.—Several important additions were made to restrictions on export and sale now in force. California established a dealer's license, and provided for registration of all purchases of game. Connecticut prohibited sale of Hungarian partridges, and made it an offense to buy as well as to sell certain game. Delaware abolished its sale license and prohibited all sale of game, with certain limited exceptions. Maine authorized the sale under permit of game from private preserves, and the export under permit of game for scientific, propagating, or advertising purposes. Michigan provided that game in captivity may be sold alive in the State and disposed of, under $1 permit, outside of the State. New York prohibited sale of all game, except a few imported species, and except deer, pheasants, mallards, and black ducks bred in captivity, and established an elaborate tagging system. Tennessee prohibited the sale of quail and sale or shipment of robins. Rhode Island prohibited sale or shipment of shore birds. North Carolina revoked the authority given the Audubon Society to issue permits for the export of quail. North Dakota prohibited sale of doves, snipe, and waterfowl. Michigan authorized the export of one day's bag limit under a nonresident hunting license. And Minnesota authorized the export under permit of deer or moose hides for tanning.

Bag limits.—A decided advance was made in limiting the bag of game. The deer limit was reduced from 2 to 1 in Minnesota and seven counties in New Hampshire. California established daily limits on rabbits, grouse, and sage hens, and a weekly limit on ducks and brant. Delaware established a limit on all game animals and birds except plover, snipe, and reedbirds. Idaho fixed a limit on the number of birds of all kinds allowed to be held in possession at one time. Kansas established a limit on snipe; Massachusetts on black ducks;

New Jersey on upland birds and waterfowl; Vermont on rabbits; and New Brunswick on partridges, woodcock, and ducks. Wisconsin limited the amount of the mixed bag a resident might have in possession at one time to 20 game birds. Bag limits were reduced by California on mountain quail; by Kansas on prairie chickens, quail, plover, and waterfowl; by Maine on ruffed grouse and woodcock; and by Minnesota and Wisconsin on grouse, prairie chicken, woodcock, partridges, shore birds, and waterfowl. On the other hand, the limit on snipe and plover was increased in Idaho, and a limit on grouse was abolished by Kansas.

Licenses.—Thirteen States and one Province of Canada modified existing license legislation. California established a dealer's license, Minnesota a separate resident big game license, New Hampshire guide licenses, South Dakota a big game resident license, Washington an alien gun license, Wyoming a bear license, and New Brunswick a sinkbox license. West Virginia, on the other hand, abolished its resident license, Vermont its alien license, and Delaware through failure of legislation, all hunting licenses. Reductions in fees were made in the importer's license in Colorado, the nonresident license of Vermont, and the resident special license of Wyoming. More liberal provisions were adopted by Idaho, which exempted veterans of the Civil War from license requirements; Michigan, which passed a law permitting a nonresident to take a day's limit of small game home; Nebraska, which allowed boys under 18 to hunt without license if accompanied by parent or guardian; New Hampshire, which placed nonresident landowners on the footing of residents; Oklahoma, which repealed its law prohibiting nonresidents from hunting deer, turkeys, and prairie chickens; and Wyoming, which passed laws allowing a nonresident paying $100 taxes annually on property in the State to take out a resident license and permitting the killing of 2 elk under the $50-nonresident license instead of requiring another $50-license for the second elk. Increased restrictions were adopted by Minnesota and Nebraska, which passed laws requiring residents to secure licenses to hunt in their own counties formerly excepted, and Massachusetts, New Hampshire, and Rhode Island, which placed age limits below which applicants can not secure licenses or must have the consent of parents or guardians. Minnesota adopted Michigan's plan of not permitting licenses to be issued until within 3 days of the opening of the season, and Michigan adopted the unique expedient of lengthening its deer season from 3 weeks to 45 days but limiting the life of each hunting license to 25 days.

Warden service.—As a result of the year's legislation the warden service of the country as a whole has been materially strengthened. More or less complete reorganizations have occurred in Delaware, Idaho, Indiana, Montana, New York, North Dakota, Oregon, Vermont, and Wyoming. In Delaware the method of placing enforcement in the hands of a private organization was abandoned and a board of fish and game commissioners provided for. In New York the work of game protection is now under the jurisdiction of the new conservation commission. Each of the three commissioners is appointed for six years at a salary of $10,000 per annum. In Oregon the fish and game departments were united, while the forestry department was separated from that of game. Increases of force or effectiveness without reorganization occurred in Iowa, Kansas, New Jersey, Oklahoma, Washington, and Wisconsin. On the other hand, the work in Delaware, Illinois and Missouri was seriously crippled by delay or reduction in the appropriations.

Preserves and propagation.—Nothing indicates the growing scarcity of game more strongly than the rapid growth in popularity of the game preserve or refuge. New State game preserves were established by Montana (three), North Dakota (two), Idaho, Washington, Manitoba (four), and Newfoundland, while Massachusetts and Oregon provided for the establishment of bird and game refuges by proclamation of the commissioners on fisheries and game and the governor, respectively. The propagation of game in State and private preserves is receiving even more attention. Massachusetts appropriated $10,000 for the establishment of a game propagating station, New Jersey $40,000 for a State game farm, and Wyoming placed $10,000 at the disposal of the State game commission for the exchange of game. California provided for the propagation and sale of pheasants raised in captivity; Maine made an exception to its nonsale law as regards game raised in private preserves; Massachusetts made a special provision for propagation of Hungarian partridges in private preserves; Michigan modified its laws so as to permit game raised in captivity to be killed for home consumption, sold alive in the State, and disposed of under permit without the State; Missouri provided for the regulation by the State game commissioner of sale and shipment of deer and elk raised in captivity; and New Jersey and Wisconsin provided for the issuance of permits authorizing the propagation of game and birds by private parties. Akin to these measures is one by Indiana directing that one-fourth of the State game and fish fund be used in the distribution of quail and other game. Montana enacted a measure ceding jurisdiction of the Glacier National Park to the United States and adopted a memorial petitioning Congress to create a game preserve out of the Snowy Mountain National Forest. A novel measure was that of Vermont authorizing the game commissioner to sell rescued deer for propagation or park purposes and to appraise deer inhabiting forest land inclosed for private parks and sell the same to the owners of such parks.

Miscellaneous provisions.—Among the miscellaneous provisions adopted during the year several are of sufficient importance or interest to justify special mention. Iowa and Kansas adopted measures declaring the ownership of game to be in the State. Michigan repealed its law prescribing a penalty for the careless shooting of human beings, while New Hampshire adopted a measure of this kind. Massachusetts prohibited trapping with scented bait and authorized arrest without warrant for the willful destruction of stone walls or fences in rabbit hunting. Michigan and Vermont adopted laws prohibiting the use of ferrets in rabbit hunting, Michigan's act also proscribing the use of guinea pigs for that purpose. South Carolina limited the baiting of fields for doves to a specified period. Texas abolished imprisonment as an alternative penalty for violation of the game laws. Utah provided for a State conservation commission to cooperate with Federal and State departments and officials. Vermont created the position of State ornithologist. Wyoming appropriated $5,000 to enable the governor and State game warden to deal with the question of preserving elk from starvation in winter. New Jersey prohibited the use of the silencer; and British Columbia, by order in council, prohibited the use of the automatic gun.

Nongame birds.—Few measures affecting nongame birds were passed during the year, but those enacted were all in the line of more rigid restriction. Kansas greatly strengthened its nongame bird law. Maine placed coots, kingfishers, blue herons, and loons on the protected list, and New Hampshire sea gulls and sheldrakes found on fresh water. New Hampshire also revoked the authority of the commissioners to permit scientific collecting, and New Jersey passed a plumage law identical with the drastic measure known as the "Shea law," adopted by New York in 1910. Porto Rico passed two acts of interest in this connection, one providing for the exclusion of flying foxes and injurious birds, insects, etc.; the other providing for the protection and introduction of birds beneficial to agriculture.

The following summary shows the principal legislation of the year in detail:

NEW LAWS PASSED IN 1911.

Federal laws.—Four acts—creating the Appalachian Park (Pub. No. 435); protecting antelope in Arizona until March 1, 1913 (Pub. No. 379); correcting a defect in the Alaska game law of 1908 so as to make the seasons for game birds uniform throughout the territory (Pub. No. 520); and appropriating $20,000 for feeding, protecting, and removing elk in Jackson Hole, Wyoming (Pub. No. 478).

Arkansas.—Laws not received.

Alabama.—One act: Changing squirrel season (ch. 496).

California.—Eight acts: Prohibiting use of any animal as a blind (ch. 13); exempting Mendocino County from law protecting squirrels (ch. 119); authorizing propagation and sale of pheasants (ch. 156); dividing the State into six districts (ch. 241); modifying seasons for game birds, placing cottontail rabbits on the game list, reducing bag limits, shortening deer season, permitting use of one dog in hunting deer, and prohibiting night shooting of game animals (ch. 404); licensing dealers in game (ch. 451); and requiring them to register purchases (ch. 452). Assembly resolution providing for investigation of fish and game commission (no.—).

Colorado.—Three acts: Changing seasons for deer and certain game birds (ch. —); extending commissioner's term to four years (ch. —); and reducing importers' license to $25 (ch. —).

Connecticut.—Five acts: Extending and enlarging nonsale law (ch. 7); extending close term for deer (ch. 14) and Hungarian partridge (ch. 18); providing for publication of game laws (ch. 64), changing the open seasons on upland game (ch.—).

Delaware.—Five acts: Establishing a board of game and fish commissioners in place of the Delaware Game Protective Association (ch. 162); directing transfer of all funds and property of said association to said board (ch. 163); restricting nonresident licensee [companion bill prescribing a nonresident license was vetoed], providing for arrest of corporations, and otherwise modifying existing laws (ch. 464); strengthening the nongame-bird law, changing seasons for game, permitting landowners to kill game in protection of premises, authorizing sale of certain noxious species of birds, prohibiting use of various devices in taking game, protecting dens and lairs of game animals, prohibiting hunting with dogs wearing bells or other noise-producing devices, establishing bag limits, strengthening nonsale law, and providing a general penalty (ch.—); and amending squirrel season (ch. 167).

District of Columbia.—No legislation.

Florida.—Eight local acts: Establishing licenses in De Soto and Lee Counties and bag limits in Brevard, De Soto, Lee, Marion, and Volusia Counties; fixing seasons in Brevard, De Soto, Escambia, Lee, Marion, Nassau, St. John, Santa Rosa, and Volusia; prohibiting shooting of upland game for 5 years in Lafayette and Taylor Counties; regulating sale of game in Brevard, Marion, and Volusia Counties; and adding a few minor restrictions in Brevard, Lee, Marion, and Volusia Counties (chs. 6252, 6262, 6280, 6290, 6291, 6300, 6305, 6310).

Georgia.—Laws not received.

Idaho.—Three acts: Reorganizing warden service, modifying seasons, increasing bag limit of snipe and plover, placing a limit on possession, modifying methods of issuing licenses and shipping permits and readjusting commissions therefor, exempting veterans of the Civil War from license requirements (ch. 62); appointing a board of control for Heyburn Park (ch. 89); and closing seasons for big game for five years in four counties, thus establishing a State preserve for big game (ch. 208).

Illinois.—Two acts: Removing woodcock from the game list for four years, extending absolute protection of ruffed grouse and imported game birds to July 1, 1915, opening a week's season in Novenber on prairie chicken with a bag limit of 3 a day, prohibiting the use of a rifle for shooting waterfowl, repealing the restriction on baiting waterfowl, repealing provision making possession of game in close season unlawful, reducing county deputy wardens from two to one, prohibiting trespass with dog or gun on water as well as land and modifying penalty for such trespass, and repealing inconsistent provisions which directed fines to be paid to the common school fund of the township in which offense was committed (S. B. 379); and abolishing separate game fund (H. B. 676).

Indiana.—Three acts: Protecting squirrels in parks (ch. 99); modifying allowance to warden (ch. 254), providing for propagation of game and birds, and altering number of deputy wardens (ch. 286).

Iowa.—Two acts: Increasing salary of warden and making salary and expenses payable from license receipts instead of State treasury (ch. 116); declaring ownership of game to be in the State and authorizing warden to capture and distribute deer (ch. 118).

Kansas.—One act: Revising and codifying the game law so as to increase the state warden's salary and place him under the supervision of the University of Kansas, licensing trapping, declaring state ownership of game, protecting squirrels, establishing a season for snipe, formerly unprotected, changing seasons for other game birds, extending and strengthening the nongame bird law, protecting nests and eggs, reducing bag limits, authorizing the marketing under permit of game raised in captivity, providing for confiscation of unlawful devices, strengthening search provisions, repealing provision for State game fund and Sunday hunting law, and modifying existing law in sundry minor particulars (ch. 198).

Maine.—Eleven acts: Enlarging scope of game fund (ch. 3); extending protection of caribou (ch. 14); authorizing export of game under permit for breeding, scientific, or advertising purposes (ch. 38); establishing a season for eider ducks, cutting off spring shooting of shore birds, restoring protection to fish-eating birds (ch. 66); providing for disposition of seized game (ch. 67); permitting sale of game birds raised in private preserves (ch. 68); reducing bag limits on ruffed grouse and woodcock (ch. 70); limiting shipment of game birds under 50-cent license to 1 pair a month (ch. 99); abolishing limitation of amount paid for damages to crops (ch. 112); opening a 2-months' season for gray squirrels (ch. 147); protecting wood duck for four years (ch. 166).

Massachusetts.—Nineteen acts: Extending absolute protection of heath hen to 1916 (ch. 18); giving absolute protection to Hungarian partridges and permitting their propagation (ch. 19); extending absolute protection of wood duck to 1916 (ch. 39); further restricting trapping of game birds (ch. 101); further protecting rabbits (ch. 118); abolishing bag limit on squirrels (ch. 172); authorizing arrest without warrant of persons willfully destroying walls or fences (ch. 173); prohibiting night shooting of waterfowl (ch. 187); placing bag limit on black duck (ch. 188); forbidding trapping with scented bait (ch. 215); further restricting use of live decoys in Nantucket County (ch. 234); strengthening resident license requirements and requiring parent or guardian's written request for applicants under 16 years of age (ch. 235); modifying protection of ruffed grouse and woodcock (ch. 236); establishing a State game farm (ch. 271); giving absolute protection to wild turkeys and regulating their importation (ch. 343); modifying quail provisions (ch. 356); authorizing the commissioners of fisheries and game to establish State bird and game preserves (ch. 410); slightly modifying license law and increasing limit of birds non-resident licensee may export (takes effect January 1, 1912,—ch. 614); and authorizing hunting on certain lands.

Michigan.—Six acts: Repealing act providing punishment for careless shooting of human beings (No. 38); permitting game raised in captivity to be killed at any time for owner's consumption and sold alive within the State and disposed of under permit outside the State (No. 50); prohibiting use of ferrets or guinea pigs in hunting rabbits (No. 180); protecting deer absolutely in eight counties to 1920 (No. 190); general act modifying and amending the game law reducing export limit of birds by club members and landowners; authorizing scientific collecting by the United States Department of Agriculture, extending period of possession of game after close of season from 5 to 30 days; making it a punishable offense to wear or possess an artificial light in hunting deer; shortening the wildfowl shooting day to extend only from sunrise to sunset; repealing permission to kill 25 quail a year in field trials; reducing bag limits, lengthening deer season to 45 days, but providing that no licensee shall hunt deer longer than 25 days from date of issue of license; establishing a season on rabbits, opening a season on quail, closing squirrel season to 1914; abolishing spring shooting of snipe, goose, and brant; making season for ruffed grouse and spruce hen uniform throughout State; modifying other seasons, and permitting nonresident licensee to take one day's bag out of State (No. 275); and placing the State fish and forestry warden under the supervision of the public domain commission as regards fires and public lands (No. 294).

Minnesota.—Four acts: Allowing export under permit of deer and moose hides for tanning (ch. 46); limiting possession of deer to persons killing same (ch. 93); regulating hunting with dogs (ch. 286); abolishing exemption of resident to hunt moose and deer in his own county without license, providing a separate license for hunting big game, reducing deer limit from 2 to 1, prohibiting issue of license until three days before opening of season, and regulating shipment of deer and moose (ch. 373).

Missouri.—Three acts: Diverting $30,000 from State game fund to State revenue fund; appropriating $90,000 of game-protection fund for expenses of warden service[1] (H. B. 1200); prohibiting hunting on lands of another without consent (H. B. 5); further regulating shipment and sale of deer and elk raised in captivity (H. B. 1077).

Montana.—Six acts: Increasing warden service (ch. 63); providing for a chief deputy game warden (ch. 28); establishing three State game preserves (chs. 87 and 100); ceding jurisdiction over Glacier National Park to the United States (ch. 33); and petitioning Congress to create a game preserve out of the Snowy Mountain National Forest (Joint Memorial No. 3 [4?]).

Nebraska.—Two acts: Modifying seasons (ch. 58); abolishing exemption from license requirement of person hunting in his own county, except on lands owned or occupied by himself; exempting from license requirements females and also boys under 18 accompanied by parents or guardians (ch. 59).

Nevada.—No legislation.

New Hampshire.—Twelve acts: Modifying season for black duck (ch. —); modifying hunting license law to require written permission from parents or guardians before license can be granted to persons under 18 (ch. —); extending absolute protection of wood duck, quail, deer, plover, and upland plover to 1916 (ch. —); revoking authority of commissioner to grant permits for scientific collecting (ch. —); exempting nonresident landowners from hunting license requirements (ch. —); making a local exception in woodcock season (ch. —); providing a penalty of $1,000 for carelessly shooting a person while hunting (ch. —); exempting Strafford County from those in which rifles may not be used in shooting deer (ch. —); giving absolute protection to sea gulls and sheldrakes inhabiting fresh water (ch. —); reducing deer limit in seven counties (ch. —); permitting use of rifle in deer hunting in 11 townships in Merrimack County (ch. —); and providing for the registration of guides with fees of $1 and $20 for residents and nonresidents, respectively (ch. —).

New Jersey.—Twelve acts: Providing $5 fees for game warden in successful prosecutions (ch. 115); allowing propagation of game birds and animals under permits (ch. 116); prohibiting use of silencer (ch. 128); strengthening nongame-bird law (ch. 168); establishing bag limits for upland birds and waterfowl (ch. 246); providing for payment of fines for use of fish and game commissioners (ch. 247); giving absolute protection to upland plover to 1916 (ch. 248); providing open seasons for Hungarian partridges and modifying other seasons so as to make them uniform (ch. 301); further restricting the allowing of dogs to run at large (ch. 321); appropriating $40,000 for a State game farm (ch. 329); adding one game warden, making one warden assistant fish and game protector, and regulating salaries (ch. 339); and modifying trespass act.

New York.—Five acts: Closing season for imported pheasants in Erie County to 1914 (ch. 170); providing for opening seasons on Saturday when first date falls on Sunday (ch. 171); regulating publication of forest, fish, and game laws (ch. 423); prohibiting sale of all game except a few imported species and captive-bred deer, pheasants, mallards, and black ducks; establishing an elaborate system of tagging such game as is marketed (ch. 438); and establishing a conservation commission of three members to replace the forest, fish, and game commission, the State water supply commissioner, and the forest purchasing board, and to have three divisions, viz, lands and forests, inland waters, and fish and game (ch. —).

North Carolina.—One general act: Revoking authority of Audubon Society to issue export permits for quail (ch. 2). Seventy-one local acts: Providing game commissioners for Craven, Currituck, and Granville counties, and adopting other game-protective measures.

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[1] The supreme court of Missouri promptly declared unconstitutional the provision in this act withholding appropriations from the present State commissioner.

North Dakota.—Five acts: Prohibiting use of firearms by person under 15 (ch. 134); providing for forfeiture of weapons found on persons arrested and convicted of crime (ch. 135); setting aside the islands in Devils Lake as a bird reserve (ch. 139); prohibiting hunting on lands without owner's permission (ch. 140); reducing board of control from five members to three at $5 per diem instead of $3, allowing the secretary a salary of $100 a month, modifying duties and authority of board, requiring chief game wardens to give all their time to their duties, reorganizing warden service, prohibiting use of artificial blinds or of rifle or automobile or other vehicle in shooting wild fowl, removing dove and swan from the game list, modifying season for goose and brant, making a few unimportant changes (ch. 141); and providing for a game preserve in Killdeer Mountains (ch. 143).

Ohio.—One act: Changing squirrel season and imposing a bag limit of five on squirrels.

Oklahoma.—Three acts: Closing deer hunting in five counties (ch. 127); removing restriction denying nonresident right to hunt deer, turkey, and prairie chicken, increasing the number of deputy wardens from 8 to 12, extending absolute protection of antelope, modifying deer season, increasing minimum fines for killing antelope from $10 to $50 (ch. 129); reimbursing the former State game warden for expenditures incurred in office (ch. 139); appropriating $62,200 from game protection fund for salaries and expenses of fish and game department (ch. 147).

Oregon.—Seven acts: Lengthening duck season in Baker County (ch. 132); uniting fish and game departments and committing forestry to a separate board (ch. 152); making restrictions on use of sink boats and power boats in hunting waterfowl uniform throughout the State (ch. 185); cutting off spring shooting of goose and swan in nine counties, but permitting the killing of white goose or brant at any time in these counties and one other (ch. 234); providing for establishment of bird and game refuges by proclamation of the governor (ch. 264); closing Chinese pheasant season in entire State for two years (ch. 268); and providing by concurrent resolution for the issuance of a compilation of the fish and game laws (No. 20).

Pennsylvania.—Acts modifying seasons, placing the raccoon on the game list, and authorizing game refuges (ch. —).

Porto Rico.—Two acts: Providing for the exclusion of the flying fox and other injurious mammals, birds, reptiles, insects, and land crabs, and establishing an inspection system (No. 60); and providing for the introduction of beneficial birds, the publication of a list of birds beneficial to agriculture, and the protection of such birds (No. 45).

Rhode Island.—Three acts: Changing seasons for shore birds and prohibiting their sale and export (ch. 688); limiting issuance of hunting licenses to applicants 15 years of age or over (ch. 690); and changing seasons for rabbit, hare, and gray squirrel (ch. 698).

South Carolina.—One act: Lengthening deer season, cutting off absolute protection of does, modifying seasons for quail, turkey, and dove, protecting wood duck, and prohibiting baiting of fields for doves during a certain specified period (No. 62).

South Dakota.—Two acts: Extending absolute protection of antelope (ch. 14); giving such protection to elk, mountain sheep, female deer, and fawn, and providing for a $5 big game resident county license (ch. 161).

Tennessee.—Five acts: Prohibiting sale of robins (ch. 18) and quail (ch. 34); extending absolute protection of deer to October 1, 1915 (ch. —); absolutely protecting quail in Shelby County to 1913 (ch. 369); and permitting quail to be shot in Sullivan County by residents November 24–February 1 on verbal permission of land owner and by nonresident guests of residents (ch. 577).

Texas.—Four acts: Removing office of game, fish, and oyster commissioner to State capitol at Austin (ch. 41); reducing counties exempted from trespass law to one—Upton (ch. 50); prohibiting export of squirrels from Liberty County (ch. 56);

abolishing imprisonment as an alternative penalty for violations of the game law, and extending the term of protection of antelope, mountain sheep, prairie chicken, and imported pheasant to 1916 (ch. 60).

Utah.—One act: Authorizing the State conservation commission to cooperate with Federal and State officials in investigating the natural resources of Utah (ch. 137).

Vermont.—Thirteen acts: Creating office of State ornithologist (No. 19); regulating fees of grand jurors in game cases (No. 91); reorganizing warden service (No. 181); changing deer season and protecting does absolutely (No. 193); providing for reopening of deer season after suspension on account of drought (No. 194); shortening season for rabbits, fixing a bag limit of six a day on them, and providing for their destruction when damaging crops or fruit trees (No. 195); reducing nonresident license fee from $15 to $10 and making minor modifications (No. 206); excepting owners of posted lands from recompense for damages by deer (No. 207); permitting killing of deer damaging crops or fruit trees (No. 208); protecting wood duck absolutely to 1916 (No. 209); prohibiting use of ferrets and regulating methods of taking game (No. 210); authorizing commissioner to sell rescued deer for propagation or park purposes and to appraise deer in forest land inclosed for private park purposes and sell same to owner of park (No. 211); increasing penalty for trespassing on posted lands and extending right of action in case of deer killed or wounded during such trespass (No. 212).

Washington.—Four acts: Creating a game refuge on Puget Sound (ch. 84); prohibiting aliens from possessing guns, except under license and consular certificate (ch. 52); modifying seasons for deer, caribou, mountain sheep, and mountain goat; protecting does at all times; authorizing search and seizure without warrant; and authorizing the county commissioners to close the season for three years on imported game birds (ch. 90); and authorizing governor to suspend open seasons during drought (ch. 125).

West Virginia.—One act: Abolishing resident license and removing the local protection given rabbits in a few counties (ch. —).

Wisconsin.—Nine acts: Authorizing propagation of game birds (ch. 166); permitting wild-fowl shooting one-half hour later each day (ch. 68); reducing bag limits (ch. 51); modifying local seasons for grouse and prairie chickens (ch. 120); reorganizing warden's office force (ch. 183); requiring hunting-license fees to be turned into the general fund of the State and limiting expenses of fish and game department to amount received from hunting and fishing licenses and sale of confiscated game (ch. 527); limiting costs in cases of trespass on wild lands (ch. 293); regulating shooting of wild fowl (ch. 389); permitting hunting of squirrels without license by landowner on his own land and modifying local protection of squirrel and rabbits (ch. 551).

Wyoming.—Three acts: Appropriating $5,000 for preservation of wild game from starvation (ch. 3); establishing a State game commission, authorizing the expenditure of $10,000 in exchanging game, transferring certain charges to the general fund instead of the State game fund, modifying the warden service, repealing Uinta County duck and goose season, extending absolute protection of moose to 1915, lengthening season for deer, elk, and mountain sheep, providing more liberal provisions in licensing nonresidents, reducing residents' special license for one additional elk from $17.50 to $5, modifying the guide law, and providing a $10 nonresident bear license (ch. 66), requesting appropriation from Federal Government for preserving big game in Wyoming (House Joint Memorial No. 1).

British Columbia.—No legislation. Three orders in council closing elk season throughout the Province and sheep season in certain districts and prohibiting the use of automatic guns.

Manitoba.—One act: Prohibiting use of motor boats in hunting waterfowl, and establishing four new game preserves.

New Brunswick.—One act: Modifying woodcock season and establishing $25 alien licenses for traffic in hides of game and fur-bearing animals. One regulation of surveyor general licensing sink boxes, prohibiting use of boats in wild-fowl shooting, fixing local season for black ducks, modifying bag limits on partridge, woodcock, and duck, and prohibiting sale of woodcock until 1912.

Newfoundland.—Two acts: Modifying caribou license provisions, prohibiting all killing of caribou in a restricted area on Grand Lake, and making a few minor modifications; modifying seasons.

Nova Scotia.—No legislation.

Ontario.—One act: Modifying woodcock season.

Quebec.—One act: Making slight changes in game laws (ch. 26).

Saskatchewan.—No legislation.

Yukon Territory.—No legislation.

OPEN SEASONS.

All the general open seasons for game prescribed by the various States and by the Provinces of Canada are here brought together in one table. For the sake of simplicity a uniform method is used in both the arrangement of species and statement of seasons. In each case deer and other big game are first considered; then rabbits and squirrels; then upland game birds, such as quail, grouse, pheasants, turkeys, and doves; then shore birds; and finally waterfowl, such as ducks, geese, and swans. In stating the seasons the plan of the Vermont law, to include the first date but not the last, has been followed consistently.[1] The Vermont scheme has the advantage of showing readily both the open and close seasons, since either may be obtained by reversing the dates of the other.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sunday is prohibited in all of the States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl in Ohio, and locally in Maryland and North Carolina; and other week days for wild fowl in several favorite ducking grounds in Delaware, Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Allegany, Baltimore, Cecil, Frederick, and Harford Counties, Md.; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland. The county laws of Maryland and North Carolina, which are too numerous to be included satisfactorily, are not incorporated in the following table,[2] which otherwise may be regarded as a practically complete résumé of the regulations now in force. The difficulty of securing absolute accuracy in a table of this kind is very great, and the absence in the laws of many States of express legislation as to the inclusion or exclusion of the date upon which seasons open and close makes exactness almost an impossibility.

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[1] See discussion of this question in Circular No. 43 of the Biological Survey, U. S. Department of Agriculture, 1904, entitled "Definitions of the open and close seasons for game."

[2] The county laws of Maryland are shown in Poster No. 25, and those of North Carolina in Poster No. 26, copies of which may be had free on application to the Biological Survey, U. S. Department of Agriculture.

OPEN SEASONS FOR GAME IN THE UNITED STATES AND CANADA 1911.

[The open seasons include the first date, but not the last. To find the close seasons, *reverse the dates.* Seasons which apply only to special counties are placed to the left of the column containing those for the State in general. Future dates, as Dec. 1, 1912, indicate that the season does not open until that time.]

Alabama (1907-1911):	*Open seasons.*
Male deer (does protected all the year)	Nov. 1-Jan. 1.
Squirrel (black, gray, or fox)	Oct. 1-Mar. 1.
Quail or partridge	Nov. 1-Mar. 1.
Wild turkey gobblers (hens protected all the year)	Dec. 1-Apr. 1.
Ruffed grouse (pheasant), imported pheasant, or other introduced game birds	Dec. 1, 1912.
Dove	Aug. 1-Mar. 1.
Plover, snipe	Nov. 1-May 1.
Curlew, sandpiper, woodcock, other shore birds, coot, mud hen, rail, duck, goose, brant, swan	Sept. 1-Mar. 15.
Alaska[1] (1910-1911):	
North of latitude 62°—	
Moose (females and yearlings protected all the year), caribou, sheep	Aug. 1-Dec. 11.
South of latitude 62°—	
Deer	Aug. 15-Nov. 2.
Mountain goat	Apr. 1-Feb. 2.
Moose (females and yearlings protected all the year), caribou (see exception), sheep.	Aug. 20-Jan. 1.
Exception: Caribou on the Kenai Peninsula, Aug. 20, 1912.	
Black bear	Aug. 1-Apr. 1.
Brown bear	Oct. 1.-July 2.
Throughout Territory—	
Grouse, ptarmigan, shore birds, waterfowl	Sept. 1-Mar. 2.
Arizona (1905-1911):	
Male deer	Sept. 15-Dec. 1.
Female deer, spotted fawn, elk, sheep, goat	No open season.
Antelope, 2 years	Mar. 1, 1913.
Quail, bobwhite, partridge, grouse, pheasant, snipe, rail	Oct. 15-Feb. 1.
Wild turkey	Sept. 15-Dec. 1.
Arkansas (1901-1909):	
Deer (except in Chicot County, Oct. 1-Feb. 1)	Sept. 1-Feb. 1.
Squirrel in Lee, Monroe, Phillips, and St. Francis Counties	May 1-Dec. 1.
Quail or partridge (except in Bradley and Dallas Counties, Nov. 15-Mar. 1)	Nov. 1-Mar. 1.
Prairie chicken, pinnated grouse	Nov. 1-Dec. 1.
Wild turkey (except in Chicot County, Feb. 1-May 15)	Sept. 1-May 1.
Pheasants (Chinese, English), 10 years	Mar. 14, 1913.
Dove	No open season.
California[2] (1901-1911):	
Male deer (second, fourth, and fifth districts)[2]	July 1-Sept. 1.
Female deer, fawn, elk, antelope, sheep	No open season.
Cottontail or bush rabbit	July 31-Feb. 1.
Tree squirrel (except Mendocino County, unprotected)	Sept. 1-Jan. 1.
Valley quail (except sixth district)[2] partridge	Oct. 15-Feb. 15.
Mountain quail, grouse, sage hen	Sept. 1-Dec. 1.
Bobwhite, imported quail or partridge, wild turkey, pheasant, swan	No open season.
Dove (first and third districts)[2]	July 15-Oct. 1.

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[1] Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimo, or by miners or explorers in need of food, but game so killed can not be shipped or sold.

[2] Seasons fixed by ordinances of boards of county supervisors are omitted. The following six fish and game districts have been established by ch. 241, laws of 1911: *First district:* Northern counties, including Del Norte, Siskiyou, Modoc, Lassen, Shasta, Trinity, Humboldt, Tehama. *Second district:* Counties north of Suisun Bay and west of the Sacramento River, including Mendocino, Glenn, Colusa, Lake, Sonoma, Napa, Yolo, Solano, Marin. *Third district:* Counties of the eastern Sacramento Valley and central Sierra, including Plumas, Butte, Sierra, Yuba, Sutter, Nevada, Placer, El Dorado, Sacramento, Amador, Alpine, Calaveras, Tuolumne, Mariposa, Mono. *Fourth district:* San Joaquin Valley counties, including San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, Kern. *Fifth District:* Counties

Open seasons for game—Continued.

California (1901-1911)—Continued.	*Open seasons.*
Wilson snipe	Nov. 15-May 1.
Plover, curlew, shore birds, ibis	Oct. 15-Mar. 1.
Rail	Nov. 1, 1912.
Duck (except first and sixth districts),[2] black brant[2]	Oct. 15-Mar. 1.
Colorado (1899-1911):	
Deer with horns	Oct. 1-Oct. 7.
Elk, 15 years	Nov. 1, 1924.
Antelope, 13 years; sheep with horns, 15 years	Sept. 25, 1924.
Deer, antelope, sheep, without horns	No open season.
Partridge, ptarmigan, wild turkey, wild pigeon	No open season.
Quail (bobwhite, crested), 13 years	Oct. 1, 1924.
Pheasant, black game, capercailzie, 4 years	Sept. 1, 1915.
Prairie chicken, mountain and willow grouse	Aug. 15-Oct. 10.
Sage chicken, dove (except dove at altitudes above 7,000 feet, July 10-Aug. 11)	Aug. 1-Sept. 2
Plover, curlew, snipe, wading, marsh, and shore birds, crane, duck, goose, brant, swan, waterfowl	Oct. 1-Mar. 2.
Connecticut (1901-1911):	
Deer, 6 years	June 1, 1917.
Hare, rabbit	Oct. 1-Jan. 15.[3]
Gray squirrel	Oct. 8-Nov. 23.
Quail, ruffed grouse, pheasant (Chinese, Mongolian), woodcock	Oct. 8-Nov. 23.
Hungarian partridge	Nov. 1, 1913.
Dove	No open season.
Plover, sandpipers, Wilson or English snipe, bay snipe, shore birds, mud hen, gallinule, duck (except wood duck), goose, brant, swan	Sept. 1-Jan. 1.
Rail	Sept. 12-Jan. 1.
Wood duck	Sept. 1, 1919.
Delaware (1893-1911):	
Rabbit, hare	Nov. 15-Jan. 1.
Squirrel (other than red)	Sept. 15-Jan. 1
Quail, partridge, pheasant, woodcock (additional woodcock season July 1-Sept. 2)	Nov. 15-Jan. 1.
Hungarian partridge	Dec. 1, 1913.
Dove (except in Newcastle County, no open season)	No open season.
Reedbird, ortolan, or rail	Sept. 1-Nov. 2.
Duck (except wood duck, Sept. 1-Nov. 1, and teal, Sept. 1-Apr. 1)	Oct. 1-Apr. 16.[4]
Goose, brant	Oct. 1-Apr. 2.[4]
District of Columbia[5] (1899-1906):	
Deer meat (sale or possession)	Sept. 1-Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel	Nov. 1-Feb. 1.
Quail or partridge	Nov. 1-Mar. 15.
Ruffed grouse or pheasant (except English, ringneck, or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey	Nov. 1-Dec. 26.
Prairie chicken (pinnated grouse)	Sept. 1-Mar. 15.
Dove	No open season.
Plover, snipe, duck, goose, brant	Sept. 1-Apr. 1.
Woodcock	July 1-Jan. 1.
Reedbird, marsh blackbird, rail or ortolan, other game birds	Sept. 1-Feb. 1.

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west of the Coast Range from Suisun Bay to San Luis Obispo, including Contra Costa, Alameda, San Francisco, San Mateo, Santa Clara, Santa Cruz, San Benito, Monterey, San Luis Obispo. *Sixth district:* Southern California, including counties of Santa Barbara, Ventura, Los Angeles, Orange, San Diego, Imperial, Riverside, San Bernardino, Inyo.

Seasons have been established in these districts as follows: Deer—First and third districts, Aug. 15-Nov. 1; sixth district, Aug. 15-Sept. 15. Valley quail—Sixth district, Oct. 15-Nov. 15. Dove—Second and fifth districts, Aug. 1-Oct. 15; fourth and sixth districts, Sept. 1-Nov. 1. Duck—First and sixth districts, Oct. 1-Mar. 1. Black brant—First district, Oct. 1-Apr. 1.

[3] Between Dec. 1 and Jan. 15 hunting with dog and ferret only.

[4] Wild fowl on Assawaman Bay and tributaries, Sussex County, Nov. 1-May 1, on Tuesdays, Wednesdays, and Fridays.

[5] Hunting prohibited in the District, by act of June 30, 1906, except on the marshes of the Eastern Branch above the Anacostia Bridge, and on the Virginia shore of the Potomac, and no birds can be shot within 200 yards of any bridge or dwelling.

Open seasons for game—Continued.

Florida[1] (1903-1911):	*Open seasons.*
Deer	Nov. 1-Feb. 1.
Quail or partridge, wild turkey	Nov. 1-Mar. 1.
Hungarian partridge, ringneck and English pheasant, other imported game birds	Nov. 1, 1912.
Duck	Oct. 1-Apr. 1.
Georgia (1905-1911):	
Deer (except does and fawns, no open season), squirrels (fox, gray)	Oct. 1-Jan. 1.
Quail, partridge, wild turkey (gobblers)	Dec. 1-Mar. 1.
Pheasant or ruffed grouse, wild turkey hens	No open season.
Dove	Oct. 1-Jan. 1.
Imported game birds	Dec. 1, 1916.
Snipe, marsh hen	Sept. 1-Mar. 15.
Woodcock, wood duck, or summer duck	Sept. 1-Feb. 1.
Idaho (1909-1911):	
Deer, elk, sheep, goat (see exceptions)	Sept. 1-Dec. 1.
Exceptions.—In Bonner, Clearwater, Idaho, Kootenai, Latah, Nez Perce, and Shoshone Counties, deer, Sept. 20-Dec. 20; elk, Sept. 1, 1916; in Fremont and Bingham Counties, elk, Sept. 1-Dec. 31; in Bear Lake, Cassia, Oneida, and Twinfalls Counties, deer, elk, sheep, and goat, Sept. 1, 1916.	
Moose, caribou, antelope, buffalo	No open season.
Quail	Nov. 1-Dec. 1.
Grouse (except north of Salmon River, Sept. 1-Dec. 1)	Aug. 15-Dec. 1.
Turtle dove (except in Fremont County, Aug. 15-Dec. 1), sage hen	July 15-Dec. 1.
Prairie chicken, Mongolian pheasant, Canada grouse, or fool hen (except north of Salmon River, Sept. 1-Dec. 1)	No open season.
Plover, snipe, duck, goose	Sept. 1-Feb. 1.
Swan	Sept. 1, 1916.
Illinois (1903-1911):	
Deer,[2] 10 years	June 15, 1919.
Squirrel (gray, red, fox, or black)	June 1-Nov. 16.
Quail	Nov. 11-Dec. 10.
Prairie chicken	Nov. 12-Nov. 18.
Partridge, blue quail, mountain quail, valley quail, Hungarian partridge, capercailzie, heath hen, black grouse, woodcock	July 1, 1915.
Wild turkey, pheasants[2] (copper or Soemmering, English, golden, green Japanese, Mongolian, ringneck, silver, tragopan, Reeves, Elliot, Hungarian, Swinhoe, Amherst, melanotte, impeyan, argus), partridge (black Indian, caccabis, chukar), sand grouse, 6 years	July 1, 1913.
Mourning dove	Aug. 2-Nov. 30.
Golden, upland, or other plover, jacksnipe or Wilson snipe, sand or other snipe, shore birds	Sept. 2-May 1.
Coot, rail, duck, goose, brant, or other waterfowl	Sept. 2-Apr. 15.
Indiana (1905-1909):	
Deer[3]	No open season.
Squirrel	July 1-Oct. 1.[4]
Quail, ruffed grouse	Nov. 10-Jan. 1.
Prairie chicken, Hungarian partridge, pheasants (copper, golden, green, Hungarian, ringneck, silver, tragopan)	Mar. 6, 1915.
Wild turkey, dove	No open season.
Woodcock	July 1-Jan. 1.[4]
Duck, goose, brant, or other waterfowl	Sept. 1-Apr. 15.

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[1] It is unlawful to kill game or game birds within 1 mile of West Palm Beach; similar regulations are in force at St. Augustine. Special seasons: Brevard and Volusia Counties, ducks on Indian River, Mosquito Lagoon, and Indian River North, Nov. 1-Apr. 1. Clay County, quail, wild turkey (except on owner's inclosed premises), Nov. 1-Mar. 1, and 2 days each week in open season. De Soto County, deer, quail, wild turkey, Nov. 1-Feb. 1. Escambia and Santa Rosa Counties, squirrel and dove, Oct. 1-Mar. 1. Lafayette and Taylor Counties, deer, squirrel, quail, and wild turkey protected until Aug. 1, 1916. Lake County, deer, squirrel (except fox squirrel May 25, 1914); quail, turkey, dove, duck, Nov. 15-Feb. 15. Lee County, deer, quail, turkey, and other wild game and birds, Nov. 1-Feb. 1. Levy County, deer, quail, turkey, dove, duck, Nov. 15-Feb. 15; fox squirrel, May 22, 1912. Marion County, deer, Sept. 1-Nov. 1; cat squirrel, Nov. 1-Mar. 1; fox squirrel, no open season; quail, wild turkey, Nov. 15-Feb. 15, on uninclosed lands, Sept. 1-Nov. 1; duck unprotected; dove, Sept. 1-Mar. 15; wood duck, Sept. 1-Apr. 1. Nassau County, squirrel, Sept. 1-Mar. 1. St. Johns County, deer, June 1-Sept. 1.

[2] Deer raised in inclosure for market may be killed Oct. 1-Feb. 1; cock pheasant, Nov. 1-Feb. 1 under permit.

[3] Deer raised in private preserves may be killed at any time.

[4] Unlawful to hunt any game except waterfowl Oct. 1-Nov. 10.

Open seasons for game—Continued.

	Open seasons.
Iowa (1807–1907):	
Deer, elk	No open season.
Squirrel (gray, timber, or fox)	Sept. 1–Jan. 1.
Quail, ruffed grouse or pheasant, wild turkey	Nov. 1–Dec. 15.
Prairie chicken (pinnated grouse)	Sept. 1–Dec. 1.
Pheasants (English, Mongolian, Chinese, ringneck)	Oct. 1, 1915.
Turtle dove	No open season.
Woodcock	July 10–Jan. 1.
Plover, sandpiper, marsh or beach birds, rail, duck, goose, brant	Sept. 1–Apr. 15.
Kansas (1903–1911):	
Deer, antelope, 10 years	Mar. 24, 1921.
Fox squirrel (red, gray, and black, no open season)	Sept. 1–Jan. 1.
Quail	Nov. 15–Dec. 2.
Grouse, prairie chicken	Oct. 1–Nov. 2.
Pheasants (English, Mongolian, or Chinese), Hungarian partridge, 6 years	Feb. 27, 1917.
Dove	No open season.
Plover	Aug. 1–May 1.
Snipe	Sept. 1–May 1.
Duck, goose, brant	Sept. 1–Apr. 15.
Kentucky (1894–1906):	
Deer	Sept. 1–Mar. 1.
Rabbit (except with dogs or snares)	Nov. 15–Sept. 15.
Squirrel (black, gray, or fox)	Nov. 15–Feb. 1.[1]
Quail, partridge, pheasant	Nov. 15–Jan. 1.
Pheasants (English, ringneck, Mongolian, or Chinese)	No open season.
Wild turkey	Sept. 1–Feb. 1.
Dove	Aug. 1–Feb. 1.
Woodcock	June 20–Feb. 1.
Wood duck, teal, or other duck, goose	Aug. 15–Apr. 1.
Louisiana (1908–1910):	
Deer (females and young protected all the year)	Oct. 1–Jan. 1.
Bear	Nov. 1–Feb. 1.
Quail, red-winged blackbird, robin	Nov. 15–Mar. 15.
Prairie chicken, pheasant (imported or native), Hungarian partridge, wild turkey hen, killdeer	Dec. 1, 1915.
Wild turkey (male)	Nov. 1–Apr. 15.
Dove, wood duck	Sept. 1–Mar. 1.
Woodcock	Jan. 1–Mar. 1.
Plover, curlew, tatler, coot (poule d'eau), gallinule, rail (mud hen), duck (except wood duck, black mallard, and blue-wing teal), goose, brant	Oct. 1–Mar. 15.
Papabotte, upland plover, grosbec, chorook	July 1–Apr. 1.
Snipe, sandpiper, blue-wing teal	Sept. 15–Apr. 1.
Florida duck (black mallard)	Aug. 1–Mar. 1.
Maine (1903–1911):	
Deer in Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington Counties (see exceptions)	Oct. 1–Dec. 15.
Exceptions: Hancock County, Eden, Mt. Desert, South West Harbor, and Tremont ... Nov. 15–Dec. 15	
Town of Isle au Haut ... Oct. 1, 1913	
Swan Island, 4 years ... Oct. 1, 1914	
Washington County, Cross and Scotch Islands ... July 3, 1919	
Deer in Androscoggin County	Oct. 1–Nov. 1.
Deer in Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties (see exceptions)	Nov. 1–Dec. 1.
Exceptions: Knox County, Camden, Rockport, and Hope; Waldo County, Lincolnville and Searsmont ... July 3, 1912	
Sagadahoc County, Bath, West Bath, and Phippsburg ... No open season	
Bull moose with at least two 3-inch prongs on horns	Oct. 15–Dec. 1.
Cow and calf moose	No open season.
Caribou, 6 years	Oct. 15, 1917.
Rabbit	Sept. 1–Apr. 1.
Squirrel, gray (black, no open season)	Sept. 1–Nov. 1.
Quail, dove	No open season.
Ruffed grouse or partridge, woodcock	Sept. 15–Dec. 1.

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[1] Also June 15–Sept. 15.

Open seasons for game—Continued.

	Open seasons.
New Jersey (1903–1911)—Continued.	
Dove, wild pigeon	No open season.
Woodcock (except in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Middlesex, Monmouth, Ocean, and Salem Counties, Nov. 15–Jan. 1).	Oct. 15–Dec. 2.
Upland plover, 5 years	Aug. 1, 1916.
Plover (except upland plover), curlew, surf (bay) snipe (except English snipe), sandpiper, yellow legs, all shore birds	May 1–Jan. 1.
English (Wilson) snipe (bog or jack snipe)	Sept. 1–Jan. 1.[1]
Reedbird, marsh hen, rail	Sept. 1–Jan. 1.
Duck[2] (except mallard, black duck, sheldrake, and wood duck), swan	Nov. 1–Mar. 16.
Wood duck	Apr. 1, 1915.
Mallard, black duck	Nov. 1–Mar. 2.
Sheldrake, goose, brant[2]	Nov. 1–Apr. 11.
New Mexico (1909):	
Deer (with horns)	Oct. 15–Nov. 16.
Deer (without horns), elk, sheep	No open season.
Antelope, 5 years	Mar. 18, 1914.
Quail (except bobwhite), grouse	Oct. 1–Jan. 1.
Bobwhite quail, pheasant, wild pigeon, 5 years	Mar. 18, 1914.
Prairie chicken	Sept. 1, 1915.
Ptarmigan (white grouse)	No open season.
Wild turkey	Nov. 1–Jan. 1.
Turtle dove	Aug. 1–Nov. 1.
Plover, curlew, snipe	Sept. 15–Mar. 2.
New York[3] (1908–1911):	
Deer—Adirondack region,[4] Dutchess County	Sept. 16–Nov. 1.
Deer—rest of State (see exception)	No open season.
Exception: Ulster County and towns of Cochecton, Tusten, Highland, Lumberland, Forestburg, Bethel, and all of towns of Mamakating and Thompson south of Newburgh and Cochecton turnpike in Sullivan County and Deer Park in Orange County . . . . Oct. 16–Nov. 1	
Fawns, elk, moose, caribou, antelope	No open season.
Hare, rabbit (except Fulton County, Oct. 1–Jan. 16)	Oct. 1–Feb. 16.
Squirrel, black or gray (except in Richmond and Niagara Counties, no open season).	Oct. 1–Dec. 1.
Quail (except in Richmond County, Nov. 1, 1914)	Nov. 1–Dec. 1.
Partridge, grouse, woodcock	Oct. 1–Dec. 1.
Hungarian partridge (European gray-legged partridge), pheasants (Mongolian ringneck, English, and others, see exceptions)	No open season.
Exceptions: Ringneck and English pheasants in Dutchess County. Nov. 1–Jan. 1	
Fulton County . . . . Sept. 16–Dec. 1	
Cayuga, Genesee, Livingston, Monroe, Niagara, Ontario, Orleans, Oswego, Seneca, Wayne, Wyoming, and Yates Counties (male pheasants may be killed Thursdays and Saturdays in October).	
Dove, wood duck	No open season.
Surf bird, plover, curlew, yellow legs, Wilson or English snipe, jacksnipe, bay snipe, shore birds, water chicken, mud hen, gallinule, rail	Sept. 16–Jan. 1.
Duck (except wood duck), goose, brant, swan	Sept. 16–Jan. 11.
Long Island (1908–1910):	
Deer	Nov. 1, 1913.
Hare, rabbit, squirrel (black or gray)	Nov. 1–Jan. 1.
Quail, grouse, woodcock (see exception)	Nov. 1–Jan. 1.
Exception: Quail on Robbins and Gardiners Islands . . . . Oct. 15–Feb. 1	
Pheasants (English, Mongolian, ringneck) in Suffolk County . . . . Nov. 1–Jan. 1	
Dove	No open season.
Plover, ringneck, killdeer, oxeye, curlew, willet, yellow legs, winter snipe, Wilson or English snipe, jacksnipe, surf snipe	July 16–Jan. 1.
Meadow hen, mud hen, gallinule	Aug. 16–Jan. 1.
Duck, goose, brant, swan	Oct. 1–Jan. 11.

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[1] Also March and April.

[2] Open season for duck, goose, and brant on Delaware River and Bay, Sept. 1–Mar. 2.

[3] When first date of open season falls on Sunday, season opens on the preceding Saturday.

[4] The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Saratoga, Saint Lawrence, Warren, and Washington, and that part of Jefferson, Lewis, and Oneida Counties lying east of the Utica and Black River R. R. from Utica to Ogdensburg.

Open seasons for game—Continued.

	Open seasons.
North Carolina[1] (1905-1909):	
Deer	Oct. 1-Feb. 1.
Quail, wild turkey, dove, lark, robin	Nov. 1-Mar. 1.
North Dakota (1909-1911):	
Deer	Nov. 10-Dec. 1.
Antelope, 11 years	Jan. 1, 1920.
Quail, English pheasant, Chinese ringneck pheasant, Hungarian partridge, dove, swan	No open season.
Ruffed grouse, prairie chicken (pinnated grouse), sharp-tailed (white breasted) grouse, golden plover, upland plover, snipe, woodcock	Sept. 7-Nov. 2.
Crane, duck	Sept. 7-Dec. 16.
Goose, brant (except on permanent waters and within ½ mile thereof, no open season).	Sept. 7-May 10.
Ohio (1900-1911):	
Rabbit	Nov. 15-Dec. 5.
Squirrel	Sept. 15-Oct. 21.
Raccoon	Nov. 1-Mar. 2.
Quail, ruffed grouse	Nov. 15-Dec. 5.
Introduced pheasants	Nov. 15, 1913.
Dove, woodcock	Sept. 1-Dec. 5.
Plover, snipe, shore birds, coot or mud hen, rail, duck, goose, swan	Sept. 1-Jan. 1.[2]
Oklahoma (1909-1911):	
Deer (except females throughout State and males in Caddo, Comanche, Delaware, Kiowa, and Swanson Counties, no open season)	Nov. 15-Dec. 15.
Antelope, 5 years	Nov. 15, 1916.
Quail, Mexican (blue) quail	Nov. 15-Feb. 1.
Grouse, wild pigeon, dove	No open season.
Prairie chicken	Sept. 1-Nov. 1.
Mongolian, Chinese, English, ringneck, or other pheasant	Nov. 1, 1914.
Wild Turkey (additional season for gobblers, Mar. 15-Apr. 15)	Nov. 15-Jan. 1.
Plover, curlew, snipe, or other shore bird, crane, duck, goose, brant, swan	Aug. 15-May 1.
Oregon (1909-1911):	
Male deer (except in Baker, Grant, Harney, Malheur, Umatilla, Union, and Wallowa Counties, Sept. 15-Nov. 1)	Aug. 1-Nov. 1.
Female deer and spotted fawn, antelope, sheep	No open season.
Elk	Aug. 1, 1919.
Silver gray squirrel	Oct. 1-Jan. 1.
Quail (see exceptions)	Oct. 15-Nov. 15.
Exceptions: Josephine and Jackson Counties — Oct. 15-Dec. 15	
Gilliam, Grant, Harney, Malheur, Morrow, Umatilla, and Wheeler Counties — Oct. 15, 1913	
Grouse, native pheasant, ruffed grouse, partridge (see exception)	Oct. 15-Nov. 15.
Exception: Baker, Grant, Umatilla, Union, and Wallowa Counties. — No open season	
Sage hen	Aug. 1-Nov. 1.
Chinese (torquatus) pheasant, 2 years	Oct. 15, 1913.
Silver pheasant, golden pheasant, copper pheasant, green Japanese pheasant, Reeves pheasant, English partridge, Hungarian partridge, bobwhite, prairie chicken (except in Grant, Harney, and Umatilla Counties, no open season)	Sept. 1-Oct. 15.
Dove, wild pigeon	Sept. 15-Jan. 1.
Turnstone, surf bird, plover, killdeer, curlew, tatler, willet, sandpiper, snipe, stilt, avocet, phalarope, other shore birds, coot, rail, goose, swan[3] (see exceptions)	Oct. 1-Mar. 1.
Exceptions: Goose, swan, in Baker, Grant, Harney, Klamath, Lake, Malheur, Sherman, Union, and Wallowa Counties (except Canadian or honker goose in Grant, Harney, and Malheur Counties, Sept. 1-Mar. 1, and except white goose and brant unprotected — Sept. 1-Feb. 1	
Goose, swan (except white goose and brant unprotected) — Sept. 1-Apr. 1	
Duck (see exceptions)	Oct. 15-Feb. 15.
Exceptions: Clatsop, Columbia, and Multnomah Counties — Sept. 1-Jan. 15	
Baker County — Aug. 1-Apr. 15	
Grant, Harney, Malheur, Morrow, Umatilla, Union, and Wallowa Counties — Sept. 1-Apr. 1	
Coos, Curry, and Lake Counties — Sept. 15-Mar. 15	
Klamath County — Sept. 1-Feb. 1	

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[1] For county seasons see special poster of Biological Survey, U. S. Department of Agriculture.

[2] Also Mar. 1-Apr. 21; Sundays and Mondays are close seasons for ducks and other waterfowl.

[3] Unlawful to kill geese at any time on islands or sand bars in the Columbia River east of the Cascades.

Open seasons for game—Continued.

	Open seasons.
Pennsylvania (1900-1911):	
Deer (deer without horns protected all the year)	Nov. 15-Dec. 1.
Bear	Oct. 1-Jan. 1.
Hare, rabbit, squirrel (gray, black, fox)	Nov. 1-Dec. 16.
Raccoon	Sept. 1-Jan. 1.
Quail, ruffed grouse, wild turkey, imported pheasants (Chinese, English, Mongolian)	Nov. 1-Dec. 16.
Hungarian partridge	Oct. 15-Nov. 16.
Dove, blackbird, reedbird, coot or mud hen, rail, sandpiper, tatler, curlew, or any shore bird	Sept. 1-Jan. 1.
Woodcock	Oct. 1-Dec. 1.
Upland or grass plover	July 15-Dec. 1.
Wilson snipe (jacksnipe)	Sept. 1-May 1.
Wild waterfowl—duck, goose, brant, swan, loon, grebe	Sept. 1-Apr. 11.
Rhode Island (1900-1911):	
Deer[1]	No open season.
Gray squirrel, hare, rabbit	Nov. 1-Jan. 1.
Quail or bobwhite, ruffed grouse or partridge, woodcock	Oct. 15-Dec. 16.
Pheasant, dove	No open season.
Hungarian partridge	Oct. 15, 1913.
Plover, yellowlegs, peep, snipe, shore, marsh, and beach birds	July 15-Dec. 16.
Black duck and wood duck	Aug. 15-Apr. 1.
South Carolina (1902-1911):	
Deer (except Berkeley County, Aug. 1-Feb. 1)	Sept. 1-Jan. 1.
Quail (partridge), wild turkey (except Berkeley County, Nov. 1-Apr. 1)	Nov. 15-Mar. 16.
Mongolian pheasant, 4 years	Jan. 1, 1912.
Dove	Aug. 15-Mar. 1.
Woodcock	Sept. 1-Jan. 15.
Willet	Nov. 1-Mar. 1.
Wood duck	Sept. 1-Mar. 1.
Grackle	Oct. 1-Mar. 1.
South Dakota (1909-1911):	
Deer (except females and fawns, no open season)	Nov. 1-Dec. 1.
Elk, antelope, mountain sheep	No open season.
Quail	Oct. 1, 1912.
Partridge, golden plover, upland plover, snipe, woodcock, grouse, prairie chicken	Sept. 10-Oct. 10.
Introduced pheasant	Jan. 1, 1915.
Dove	No open season.
Duck, goose, brant, any aquatic fowl	Sept. 10-Apr. 10.
Tennessee (1903-1911):	
Deer (except Fentress County, Dec. 1-Jan. 1)	Oct. 1, 1915.
Squirrel	June 1-Mar. 1.[2]
Quail or partridge (except Shelby County, Nov. 15, 1913)	Nov. 15-Mar. 1.
Grouse, pheasant (except English or ringneck pheasants), wild turkey,[3] meadowlark	Nov. 1-Mar. 1.
Pheasant, English or ringneck	Dec. 1-Jan. 1.
Dove (except in Shelby County, Mar. 1-July 15); teal, wood (summer) duck	Aug. 1-Apr. 15.
Woodcock, robin, marsh blackbird, plover, curlew, tatler, willet, godwit, sandpiper, snipe, avocet, coot, mud hen, rail, duck (except teal and wood duck), goose, brant, swan	Oct. 1-Apr. 15.

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[1] Tame deer kept in confinement may be killed by the owner at any time, or any deer injuring crops, by the owner or occupant of the premises, under permit from secretary of state.

[2] *Special squirrel seasons:* Benton, Decatur, Wilson, June 1-Jan. 1; Carroll, June 15-Mar. 1; Carter, July 15-Mar. 1; Crockett, Weakley, July 1-Feb. 1; Dyer, June 1-July 1 and Oct. 1-Jan. 1; Fayette, July 15-Jan. 1; Gibson, Sevier, June 1-Feb. 1; Hardeman, July 15-Feb. 15; Haywood, May 1-Jan. 1; Henderson, July 15-Jan. 15; McNairy, Madison, July 1-Mar. 1; Robertson, July 1-Jan. 1; Shelby, June 15-Feb. 1; Stewart, Aug. 1-Feb. 1; Warren, Oct. 1-Mar. 1. Bedford, Blount, Cannon, Clay, Coffee, Cumberland, Dickson, Fentress, Giles, Greene, Hickman, Humphreys, Jackson, Knox, Lawrence, Lincoln, London, Marshall, Maury, Meigs, Moore, Overton, Perry, Pickett, Putnam, Rhea, Sequatchie, Sullivan, Van Buren, Washington, Wayne, White, Williamson, unprotected.

In Chester, Hardeman, Hardin, and McNairy Counties anyone may kill squirrels on his own property at any time for his own use

[3] *Special wild turkey seasons:* Dyer (gobblers), Nov. 1-May 1 (hens), Nov. 1-Feb. 1; Clay, Fentress, Overton, Pickett, Aug. 1-May 1.

Open seasons for game—Continued.

		Open seasons.
Texas (1907-1911):		
Deer (female deer and spotted fawn protected all the year)		Nov. 1-Jan. 1.
Antelope, sheep, 5 years		Nov. 1, 1916.
Quail or partridge, dove		Nov. 1-Feb. 1.
Prairie chicken or pinnated grouse, pheasants (Mongolian, English), 5 years		Nov. 1, 1916.
Wild turkey		Dec. 1-Apr. 1.
Utah (1909):		
Deer (see exception)		Oct. 15-Nov. 15.
Exception: Nonresident not permitted to kill deer.		
Elk, antelope, sheep		Mar. 11, 1913.
Quail, partridge, grouse, prairie chicken, pheasants (Chinese, English, Mongolian) (see exceptions)		Mar. 11, 1913.
Exceptions: Quail in Garfield, Kane, and Washington Counties	Aug. 1-Feb. 1	
Quail in Carbon, Davis, Salt Lake, Sevier, Utah, and Weber Counties	Oct. 1-Nov. 1	
Sage hens in Beaver, Box Elder, Carbon, Emery, Garfield, Grand, Iron, Kane, Millard, Morgan, Piute, Rich, San Juan, Sanpete, Sevier, Summit, Uinta, Wasatch, Washington, Wayne, and Weber Counties		Aug. 1-Dec. 1.
Sage hens in Cache, Davis, Juab, Salt Lake, Tooele, and Utah Counties		Mar. 11, 1913.
Dove		Aug. 1-Dec. 1.
Snipe, shore birds, duck, goose, brant, swan		Oct. 1-Jan. 1.
Vermont[1] (1894-1911):		
Deer with horns not less than 3 inches long (no open season for others)		Nov. 15-Nov. 26.
Moose, caribou		No open season.
Hare, rabbit		Sept. 15-Mar. 1.
Gray squirrel		Sept. 15-Dec. 1.
Quail		Sept. 15-Dec. 1.
Ruffed grouse (partridge), woodcock		Sept. 15-Nov. 15.
Pheasant, English partridge		Oct. 1, 1913.
Dove, rail, swan		No open season.
Plover (other than upland), English snipe		Sept. 15-Dec. 1.
Upland plover		Aug. 1, 1915.
Duck (except wood duck, Sept. 16, 1916), goose		Sept. 1-Jan. 1.
Virginia[3] (1903-1910):		
Deer (except in Brunswick and Greenesville Counties, Oct. 1-Feb. 1)		Sept. 1-Dec. 1.
Rabbit		Nov. 1-Feb. 1.[4]
Squirrel:		
Brunswick and Greenesville Counties	Nov. 1-Feb. 1[5]	
Isle of Wight and Southampton Counties (gray or fox)	Sept. 1-Jan. 15	
Warren County	Nov. 15-Jan. 1	
Opossum in Halifax County	Oct. 15-Feb. 1	
Quail or partridge, pheasant or grouse, wild turkey, woodcock (see exceptions)		Nov. 1-Feb. 1.
Exceptions: West of the Blue Ridge	Nov. 1-Jan. 1	
Dove in Brunswick and Greenesville Counties	Aug. 15-Jan. 15	
Robin		Feb. 15-Apr. 1.
Surf bird, plover, curlew, tatler, willet, sandpiper, snipe (except Wilson and robin snipe), mud hen, gallinule, rail (except sora)		July 20-Jan. 1.
Summer or wood duck, winter waterfowl in Brunswick and Greenesville Counties	Aug. 1-Jan. 1	
Winter waterfowl (except in Brunswick and Greenesville Counties)		Oct. 15-May 1.[6]
Washington[7] (1903-1911):		
Deer (males only), caribou, sheep, goat		Sept. 1-Nov. 1.
Elk		Oct. 1, 1915.
Moose, antelope (males only)		Sept. 15-Nov. 1.

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[1] The governor is authorized to suspend open seasons in time of drought and fix another open season for deer in such event.

[2] Deer kept in private game preserves may be killed by the owners at any time.

[3] Boards of supervisors may shorten the open seasons in their counties and make other restrictions not repugnant to law "and may include in such protection other game not specifically mentioned in this section." Code 1904, sec. 2070a, as amended in 1906.

[4] Residents of the State may kill rabbits on their own lands at any time.

[5] Residents of State may kill squirrels on their own lands at any time.

[6] Wildfowl can not be hunted on Wednesdays and Saturdays on Back Bay, Princess Anne County.

[7] On Mercer Island and shores of Lake Washington game animals and birds are protected all the year. (Laws 1909, ch. 54.)

Open seasons for game—Continued.

		Open seasons.
Washington (1903-1911)—Continued.		
Female deer, moose, antelope, and spotted fawn		No open season.
Quail, ruffed grouse, grouse, prairie chicken, sage hen, pheasant, and other imported upland game birds (see exceptions)		Oct. 1-Jan. 1.
Exceptions: Quail in Clallam, Clarke, Kitsap, Skagit, and Whatcom Counties, and counties east of Cascades	Oct. 1, 1912	
Partridge, pheasant (Chinese ringneck, English, and golden), in same counties and also Snohomish County	Oct. 1, 1912	
Grouse in Douglas, Ferry, Okanogan, and Stevens Counties	Aug. 15-Jan. 1	
Grouse in other counties east of Cascades	Sept. 1-Oct. 16	
Prairie chicken in Adams, Chelan, Columbia, Douglas, Ferry, Garfield, Grant, Lincoln, Okanogan, Stevens, and Wallawalla Counties	Sept. 1-Oct. 16	
Prairie chicken in other counties east of Cascades	Sept. 1, 1912	
Hungarian partridge		Oct. 1, 1913.
Dove		No open season.
Plover, curlew, snipe, rail, other shore birds, duck, goose, brant, swan (see exception)		Oct. 1-Feb. 1.[1]
Exception: In Adams, Douglas Ferry, Grant, Lincoln, Okanogan, Spokane, Stevens, and Whitman Counties	Sept 15-Jan. 1	
West Virginia (1909-1911):		
Deer (with horns more than 4 inches long—no open season for any other deer)		Oct. 15-Dec. 1.
Squirrel (gray, black, red, fox)		Sept. 1-Dec. 1.
Quail (Virginia partridge)		Nov. 1-Dec. 1.
Ruffed grouse (pheasant), wild turkey		Oct. 15-Dec. 1.
Pheasants (English, Chinese, Reeves, Lady Amherst), capercailzie, or any other introduced foreign game bird, dove, wood duck		No open season.
Plover, sandpiper, woodcock, reedbird, rail (ortolan)		July 15-Dec. 20.
Snipe		Oct. 15-Mar. 1.
Duck (except wood duck, no open season), goose, brant		Sept. 1-Apr. 20.
Wisconsin (1898-1911):		
Deer (see exceptions)		Nov. 11-Dec. 1.
Exceptions: Door and Shawano Counties, 5 years	Nov. 11, 1912	
Adams, Brown, Buffalo, Calumet, Columbia, Crawford, Dane, Dodge, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Kenosha, Kewaunee, La Crosse, Lafayette, Manitowoc, Marquette, Milwaukee, Monroe, Outagamie, Ozaukee, Pepin, Portage, Racine, Richland, Rock, Sauk, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara, and Winnebago Counties	No open season	
Moose		No open season.
Rabbit, in Eau Claire, Pierce, Portage, Waupaca, and Waushara Counties		Sept. 10-Feb. 1.
In Brown, Calumet, Columbia, Dane, Dodge, Dunn, Green, Green Lake, Jefferson, Juneau, Kewaunee, La Crosse, Lincoln, Manitowoc, Milwaukee, Outagamie, Ozaukee, Rock, Sheboygan, Trempealeau, Walworth, Washington, Waukesha, and Wood Counties		Oct. 10-Feb. 1.
Squirrel (gray, fox, black, see exceptions)		Oct. 10-Feb. 1.
Exceptions: Chippewa, Eau Claire, Pierce, Portage, Rusk, St. Croix, Waupaca, and Waushara Counties	Sept. 10-Feb. 1	
Waukesha County	No open season	
Quail, pheasants (Chinese, English, Mongolian), 8 years		Oct. 1. 1915.
Partridge, plover, snipe, woodcock		Sept. 10-Dec. 1.
Prairie chicken, grouse: In Adams, Ashland, Barron, Bayfield, Brown, Burnett, Buffalo, Chippewa, Clark, Crawford, Dodge, Douglas, Dunn, Eau Claire, Grant, Iowa, Jackson, Juneau, Lafayette, Marquette, Monroe, Oconto, Outagamie, Pepin, Pierce, Polk, Portage, Richland, Rusk, St. Croix, Sawyer, Shawano, Vernon, Washburn, Waupaca, Waushara, and Wood Counties		Sept. 10-Oct. 1.
Prairie chicken, grouse: In rest of State		Sept. 1, 1915.
Dove, swan		No open season.
Coot or mud hen, rail, rice hen, duck		Sept. 1-Jan. 1.
Goose, brant		Sept. 10-May 1.
Wyoming (1909-1911):		
Deer		Sept. 1-Dec. 1.
Moose, elk, sheep (except elk and male sheep in Carbon, Fremont, and Uinta Counties and in Big Horn and Park Counties west of Big Horn River, Sept. 1-Dec. 1), antelope, 4 years		Sept. 1. 1915.

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[1] Shore birds, geese, and brant may also be shot Mar. 1-June 1 in Chehalis, Clallam, Jefferson, Pacific, and San Juan Counties, along the coast and 5 miles inland.

Open seasons for game—Continued.

Wyoming (1909-1911)—Continued.	*Open seasons.*
Quail, Mongolian pheasant, 3 years	Sept. 25, 1912.
Grouse, other than sage grouse (see exception)	Sept. 25-Dec. 1
Exception: Albany, Carbon, Laramie, and Sweetwater Counties	Aug. 1-Sept. 16
Sage grouse (except in Natrona and Sheridan Counties, Aug. 1, 1915), curlew	Aug. 1-Oct. 1.
Dove, swan	No open season.
Sandpiper, snipe, or other shore bird (except curlew), duck, goose	Sept. 1-May 1.
Alberta[1] (1906-1909):	
Deer, elk or wapiti, moose, caribou	Nov. 1-Dec. 15.
Antelope	Oct. 1.-Nov. 1.
Buffalo	No open season.
Sheep, goat	Sept. 1-Oct. 15.
Partridge except Hungarian partridge, grouse, prairie chicken, ptarmigan, pheasant (except English, no open season)	Oct. 1-Nov. 1.
Plover, curlew, sandpiper, snipe, shore bird, coot, rail, crane	Sept. 1-Jan. 1.
Duck,[2] swan	Aug. 23-Jan. 1.
British Columbia[3] (1898-1911):	
Deer, goat	Sept. 1-Dec. 15.
Bull elk or wapiti, bull moose, bull caribou, hare	Sept. 1-Jan. 1.[3]
Sheep, rams only	Sept. 1-Nov. 15.[3]
Young of deer and females and young of elk, moose, caribou, and sheep	No open season.
Bear	Sept. 1-July 15.
Quail, English partridge, prairie chicken, pheasant, black game, capercailsie, snipe, goose, swan	No open season.[3]
Grouse, ptarmigan, duck north of latitude 55° (in rest of Province no open season [3])	Sept. 15-Mar. 30.
Plover, bittern, heron, meadowlark	Sept. 1-Mar. 1.
Manitoba (1909):	
Deer, elk or wapiti, moose, caribou or reindeer, antelope or cabri (males)	Dec. 1-Dec. 15.
Females and young of foregoing species and bison or buffalo	No open season.
Quail, woodcock, plover (except upland plover), sandpiper, snipe	Aug. 1-Jan. 1.
Partridge, prairie chicken, grouse	Oct. 1-Oct. 20.
Dove	No open season.
Pheasant, 11 years	Oct. 1, 1920.
Upland plover	July 1-Jan. 1.
Duck	Sept. 1-Dec. 1.
New Brunswick (1909-1911):	
Deer, moose, caribou (cow and calf moose and cow caribou, no open season)	Sept. 15-Dec. 1.
Partridge, snipe, woodcock	Sept. 15-Dec. 1.
Pheasant	No open season.
Teal, wood duck, dusky or black duck, goose, brant	Sept. 1-Dec. 2.
Shore or other birds on beaches, islands or lagoons bordering tidal waters of Northumberland Strait, Gulf of St. Lawrence, and Bay of Chaleur	Aug. 15-Jan. 1.
Newfoundland[4] (1902-1911):	
Elk, moose, 10 years	Jan. 1, 1912.
Caribou (except in a special region near Grand Lake, no open season)	Oct. 21-Feb. 1.[5]
Ptarmigan, willow grouse or partridge, plover, curlew, snipe, or "other wild or migratory birds (except wild geese)"	Sept. 20-Dec. 15.
Capercailzie, black game, 10 years	Oct. 12, 1917.

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[1] North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food.

[2] Except white-winged scoters, north of township 50, which may be taken at any time.

[3] The lieutenant governor in council is empowered to open seasons each year for coast or Columbian deer, quail, English partridge, prairie chicken, pheasant, capercailzie, black game, snipe, and goose, and for grouse, ptarmagin, and duck south of latitude 55°. The following special seasons have also been made by orders in council: Elk, on Vancouver Island, Sept. 1, 1913, on mainland, Sept. 1, 1912; moose, in the East Kootenay district, no open season; mountain sheep, in the Yale, Okanogan, and Similameen districts, Sept. 1, 1913; south of the Canadian Pacific Railway, from the coast to Columbia River and from Revelstoke to the international boundary, no open season. Resident Indians (nonresidents not allowed to hunt) and farmers in "unorganized districts" may kill deer for immediate use as food, but Indians can kill does and fawns only Aug. 1-Feb. 1; free miners engaged in placer mining or prospecting in unorganized districts, and surveying or engineering parties engaged in their duties may kill any game for food.

[4] Poor settlers may kill any birds, except capercailzie and black game, at any time, for immediate consumption by themselves or their families.

[5] Additional open season Aug. 1-Oct. 1.

Open seasons for game—Continued.

	Open seasons.
Nova Scotia (1908-1910):	
Deer, caribou, 4 years	Oct. 1, 1912.
Moose (see exceptions)	Sept. 16-Nov. 16.
Exception: Cape Breton Island	Oct. 1, 1915
Calf moose under 1 year	No open season.
Cow moose	Sept. 20, 1912.
Hare, rabbit	Nov. 1-Mar. 1.
Quail, sharp-tailed grouse, ptarmigan, plover, curlew, yellow legs, sandpiper, snipe, heron, bittern, beach birds, waders, teal, wood duck	Aug. 15-Mar. 1.
Ruffed grouse or birch partridge	Oct. 1-Nov. 1.
Canada grouse (spruce partridge), chukar partridge, pheasant, capercailzie, black game	No open season.
Woodcock, blue-winged duck	Sept. 1-Mar. 1.
Exception: Blue-winged duck in Cumberland County	Sept. 1-May 1.
Ontario[1] (1907-1911):	
Deer (except in Simcoe County, to Nov. 1, 1912, and except fawns, no open season).	Nov. 1-Nov. 16.[2]
Elk or wapiti	No open season.
Moose, caribou, or reindeer (see exception)	Oct. 16-Nov. 16.[3]
Exception: Female moose and young moose and caribou	No open season.
Hare[4]	Oct. 1-Dec. 16.
Squirrel (black or gray)	Nov. 15-Dec. 2.
Quail, wild turkey	Nov. 15-Dec. 2.
Partridge, grouse, prairie fowl, pheasant	Oct. 15-Nov. 16.
Capercailzie	Sept. 15, 1915.
Woodcock	Oct. 1-Nov. 16.
Plover, snipe, rail, other shore birds or waders	Sept. 1-Dec. 16.
Dove	No open season.[5]
Duck and other waterfowl (except goose and swan)	Sept. 15-Dec. 16.
Goose, swan	Sept. 15-Apr. 16.
Prince Edward Island (1906-1907):	
Hare, rabbit	Sept. 1-Mar. 1.
Partridge	Oct. 1-Dec. 1.
Plover, curlew	July 15-Jan. 1.
Snipe, woodcock	Sept. 1-Jan. 1.
Yellow legs, shore and other birds along beaches or tidal marshes, teal, black or blue-winged duck	Aug. 20-Jan. 1.
Goose	Sept. 15-May 10.
Brant	Oct. 1-June 10.
Quebec (1899-1910):	
Zone 1.[6] Deer, moose (see exceptions)	Sept. 1-Jan. 1.
Exceptions: In Ottawa and Pontiac Counties	Oct. 1-Dec. 1
Cow moose and young deer and moose	No open season.
Caribou (young, no open season)	Sept. 1-Feb. 1.
Hare	Dec. 1-Feb. 1.
Bear	Aug. 20-July 1.
Birch or swamp partridge	Sept. 1-Dec. 15.
White partridge or ptarmigan	Nov. 1-Feb. 1.
Woodcock, plover, curlew, tattler, sandpiper, snipe	Sept. 1-Feb. 1.
Widgeon, teal, duck (except sheldrake), gull, loon	Sept. 1-Mar. 1.[7]
Zone 2. Close seasons same as in Zone 1, except as follows:	
Caribou	Sept. 1.-Mar. 1.
Hare	Oct. 15-Mar. 1.
Birch or swamp partridge	Sept. 15-Feb. 1.
White partridge or ptarmigan	Nov. 15-Mar. 1.

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[1] Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[2] Persons who put deer on their own lands, and their licensees, may hunt such deer Oct. 1-Nov. 16.

[3] South of the Canadian Pacific R. R., between Mattawa and the Manitoba boundary, Nov. 1-16.

[4] Cottontail rabbits (wood hares) may be killed during close season when damaging trees or shrubs.

[5] Under act for protection of insectivorous birds, Rev. Stats., 1897, ch. 289, sec. 3.

[6] Zone No. 1 comprises the whole Province, except that part of the counties of Chicoutimi and Saguenay east and north of the River Saguenay. Zone No. 2 comprises the excepted part of said counties.

[7] Inhabitants of Zone 2 and Gaspé County may take these birds for food Aug. 1-June 1.

Open seasons for game—Continued.

	Open seasons.
Saskatchewan[1] (1905-1907):	
Deer, elk or wapiti, moose, caribou (females and young, no open season)	Dec. 1-Dec. 15.
Antelope (young, no open season)	Oct. 1-Nov. 15.
Buffalo	No open season.
Partridge, prairie chicken, grouse, ptarmigan	Oct. 1-Nov. 1.
English pheasant	No open season.
Plover, curlew, sandpiper, snipe, shore birds, coot, rail, duck, goose, swan	Sept. 1-Jan. 1.
Crane	Aug. 1-Jan. 1.
Unorganized Territories[2] (Keewatin, Mackenzie, etc.) (1894-1906):	
Deer, elk or wapiti, moose, caribou, goat, sheep	Dec. 1-Apr. 1.[3]
Buffalo	Jan. 1, 1912.
Musk ox	Oct. 15-Mar. 20.
Partridge, prairie chicken, grouse, pheasant	Sept. 1-Jan. 1.
Duck, goose, swan	Sept. 1-Jan. 15.
Yukon[4] (1902-1906):	
Deer, elk or wapiti, moose, caribou, sheep, goat, musk ox	Sept. 1-Mar. 1.
Bison or buffalo	No open season.
Partridge, prairie chicken, grouse, ptarmigan, pheasant	Sept. 1-Mar. 15.
Sandpiper, snipe, crane, duck, goose, swan	Aug. 10-June 1.

SHIPMENT OF GAME.

Shipment is the most important feature of the traffic in game. If permitted without limitation it is a great factor in game destruction. A realization of this fact has induced many of the States to prohibit export of all or certain kinds of game, and in a few instances all transportation even within the State. The subject may be conveniently considered under the following subheads: "Federal laws," and "State laws prohibiting export."

FEDERAL LAWS.

Federal laws affecting the shipment of game comprise the statutes regulating interstate commerce in game and the importation of birds from foreign countries, and those providing for the protection of birds and game on territory under immediate Federal jurisdiction.

They comprise: (1) Sections 241 to 244 of the Criminal Code (35 Stat., 1137), regulating the importation and interstate shipment of game;[5] (2) the tariff act, imposing duties on game, skins, and feathers imported from foreign countries; (3) the act regulating the introduction of eggs of game birds; (4) the game law of Alaska; and (5) provisions for protecting birds in the national parks,[6] national forests, and other Government reservations. These laws are more fully discussed in Bulletin No. 16 of the Biological Survey, entitled "Digest of Game Laws for 1901" (pp. 69–79). The full text of the new Alaskan game law of 1908, with the regulations now in force, is published in circulars Nos. 66 and 75 of the Biological Survey. Sections 241, 242, 243, and 244 of the Criminal Code of the United States are as follows:

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[1] Lieutenant governor in council may extend close seasons over current year within limits on petition of six game guardians.

[2] Indians, inhabitants, travelers, explorers, and surveyors in need of food exempt. Governor in council may alter seasons.

[3] Also July 15-Oct. 1.

[4] Indians, explorers, surveyors, prospectors, miners, and travelers in need of food are exempt. Commissioner in council may alter seasons.

[5] These sections are sections 2, 3, and 4 of the Lacey Act as amended.

[6] The law governing the Yellowstone Park prohibits any person, or any stage, express, or railway company from receiving for transportation animals, birds, or fish taken in the park, under a penalty not exceeding $300. (28 Stat., ch. 72, sec. 4.)

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes" or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof, any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any State, Territory, or District of the United States, to any other State, Territory, or District thereof, any foreign animals or birds, the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper, and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than two hundred dollars; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than two hundred dollars; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than two hundred dollars.

STATE LAWS PROHIBITING EXPORT.

Since the constitutionality of the Connecticut statute prohibiting export of certain game was established by the supreme court in 1896,[1] nonexport laws have been generally adopted, and at the present time every State prohibits the export of certain kinds of game. In some States sportsmen are allowed to carry a limited amount of game out of the State under special restrictions, and exceptions to the laws prohibiting export are also made in the case of birds and animals intended for propagation.

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[1] Geer *v.* Conn., 161 U. S., 519.

Restrictions on shipment from the State have now become so stringent that all the States and Territories west of the Mississippi River, except two, North and South Dakota, prohibit export of all game protected by local laws, and these permit the export of only plover, woodcock, and cranes. East of the Mississippi, laws prohibiting the export of all game, or, in some cases, all but one or two unimportant species, are in force in all the States except a small group along the coast from Massachusetts to Maryland and four Southern States—North Carolina, Georgia, Florida, and Kentucky.

Special attention is called to the following table, which contains a list of the game prohibited from export by each State and Territory:

Export of Game Prohibited.

Alabama: All protected game.

Exceptions: Nonresident licensee may take with him or have carried to him, openly, game lawfully killed by him. State game and fish commissioner may issue permit to any person to capture, kill, or export game birds at any time, dead or alive, for scientific or propagating purposes.

Alaska: Deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof.

Exceptions: Specimens may be exported under restrictions imposed by the Secretary of Agriculture, and trophies of big game under licenses issued by the governor.[1]

Arizona: All protected game, and duck, goose, and brant.

Arkansas: Deer (unless raised in captivity), wild turkey, wild fowl, game of any description except rabbits, which must be shipped open to view. (Squirrels can not be shipped out of Craighead, Dallas, Lafayette, and White Counties.) Local exceptions in Clay and Mississippi Counties.

California: All protected game.

Colorado: All protected game.

Exceptions: Game may be exported under permit from game commissioner if permit be attached and package plainly marked so as to show nature of contents. The following fees are charged for export permits: Elk, $10; deer, $5; sheep, $5; bird, 25 cents—in each case the edible portion alone.

Connecticut: Quail, ruffed grouse, woodcock.

Delaware: Rabbit, quail, partridge, woodcock (nonresidents also prohibited from shipping English snipe). Squirrel, dove, rail, reedbird, goose, brant, for sale.

Florida: Deer, deer hides, quail or partridge, wild turkey from county; ducks for sale from Brevard and Volusia Counties.

Georgia: Quail or partridge.

Idaho: All protected game.

Exceptions: Any hunter may export, under hunting license, big game lawfully taken, under a 50-cent permit obtained from a justice of the peace, probate judge, game warden, or deputy game warden on a sworn statement to issuing officer that game was not procured contrary to law. Mounted heads and stuffed birds legally secured may be exported.

Illinois: Squirrel, quail, ruffed grouse, pinnated grouse, prairie chicken, pheasant, wild turkey, shore birds, duck, goose, brant, taken in the State.

Exceptions: Game may be exported under license from the State. Nonresident may take from State 50 birds killed by himself, if carried openly for inspection.

Indiana: Deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl.

Exception: Nonresident may take from State 15 birds killed by himself, if carried openly for inspection together with his license, or 45 if he has hunted for 3 or more days consecutively.

Iowa: All protected game.

Exception: Nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection, and if hunting license be shown on request.

Kansas: All protected game.

Kentucky: Quail, partridge, grouse, pheasant, wild turkey killed in the State.

Louisiana: All protected game.

Exception: A nonresident licensee may carry with him out of the State, under his license, or as baggage, if exposed to view, 1 turkey gobbler, 25 ducks, snipe, or rail, 15 of other game birds. Export of deer regulated by board of game commissioners.

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[1] See p. 46 and also Circular No. 66, Biological Survey, U. S. Department of Agriculture.

Export of game prohibited—Continued.

Maine: Deer, moose, quail, ruffed grouse, pheasant, capercailzie, black game, plover, woodcock, snipe, sandpiper, wood duck, dusky or black duck, teal, gadwall or gray duck, mallard, widgeon or baldpate, shoveler, pintail or sprigtail, redhead, scaup or greater bluebill, lesser scaup or lesser bluebill, golden-eye or whistler, bufflehead, ruddy duck, or broadbill.

Exceptions: A resident of the State may export 1 deer in a season if open to view, tagged to show name and address of owner and accompanied by him, and under shipping license 1 moose, 6 partridges,[1] 10 woodcock, and 10 ducks lawfully killed by himself. A nonresident may export under hunting license 1 moose and 2 deer lawfully killed by himself and may take home 10 partridges,[1] 10 ducks, and 10 woodcock; he may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding, scientific, or advertising purposes, under permit of the commissioners of inland fisheries and game.

Maryland: *County provisions, as follows:*

Allegany—Deer, squirrel, rabbit, partridge or quail, pheasant, English pheasant, turkey, dove, woodcock from county (for sale).

Anne Arundel—All protected game, viz: Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover, duck, goose, brant, swan from county.

Baltimore—Partridge, pheasant from county.

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Caroline—Rabbit, quail, partridge, woodcock from county.

Cecil—Squirrel, quail, grouse, woodcock, plover from county.

Dorchester—Squirrel, rabbit, quail, partridge, woodcock, dove (for sale).

Exception: Twelve quail or partridges, 6 squirrels, rabbits, woodcock, and doves may be taken out of the county at one time as personal baggage, if carried openly and not intended for sale.

Frederick—Squirrel, partridge, pheasant, woodcock from county (for sale).

Garrett—Partridge (quail), pheasant, wild turkey, woodcock from county.

Exception: Nonresident may take out game killed under his hunting license.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).

Montgomery—Partridge, pheasant, wild turkey from county (for sale).

Queen Anne—Rabbit, partridge, woodcock, from county (for sale).

Somerset—All game, viz: Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose, from county.

Washington—Deer, squirrel, rabbit, partridge, pheasant, woodcock, wild turkey from county (for sale)

Wicomico—Quail or partridge from Wicomico and Worcester Counties considered as one territory.

Worcester—Rabbit, quail, woodcock from county.

Massachusetts: Quail, ruffed grouse, woodcock taken in State; other game illegally taken in State.

Exception: Nonresident may take 6 birds out of the State under his hunting license.

Michigan: All protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out 1 deer under permit from State warden, and also, as hand baggage, 1 day's bag limit of birds.

(3) Landowners and members of clubs owning game preserves may ship during open season under a $10 permit from State warden 20 ducks or other migratory birds killed by them on their own premises.

Minnesota: All protected game.

Exceptions: Nonresident licensee may ship home in open season under his license coupons 1 deer and 25 birds lawfully taken by himself. Domesticated big game may be exported under permit, and also deer and moose hides for tanning.

Mississippi: All protected game.

Missouri: All protected game.

Exceptions: Game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him. Export for scientific or propagating purposes allowed under permit. Deer or elk raised in captivity may be shipped at any time.

Montana: All protected game.

Exception: Game lawfully killed may be exported in open season if accompanied by owner, and resident's shipping permit from State game and fish warden, or nonresident's hunting license; total shipment under one license not to exceed season's bag limit; packages to be labeled to show contents.

Nebraska: All protected game.

Exception: Nonresident may ship 50 birds out of State under hunting license, but must give common carrier invoice of number and kind of birds, must have details of shipment marked on license, and must accompany the shipment.

Nevada: All protected game.

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[1] But see bag limit of 5 ruffled grouse (partridges) on p. 41.

Export of game prohibited—Continued.

New Hampshire:[1] Deer (except heads for mounting), elk, moose, caribou, quail, partridge, ruffed grouse, pheasant, woodcock, Wilson snipe, dove, plover, yellowlegs, sandpiper, rail, duck (except sheldrake), and all "beach" birds.

Exceptions: Deer may be exported by resident if accompanied to office of carrier by owner, shipped open to view, properly tagged, and labeled with name of actual owner. Nonresident may export, under his hunting license, 2 deer and 12 birds, carried open to view, on notice of number and kind to the commissioner who issued the license.

New Jersey: Squirrel, hare, rabbit, quail or partridge, ruffed grouse or pheasant, pinnated grouse, English pheasant, ringneck pheasant, woodcock.

Exception: English or ringneck pheasants killed on preserves established prior to April 15, 1903, may be exported from the State. Nonresident licensee may export 10 rabbits and 15 birds a day if carried openly.

New Mexico: Export for market of all game protected by the State.

Exception: The territorial warden is authorized to issue transportation permits at $1 each ($2 in case of deer), and also to permit export of game or birds for scientific or propagating purposes.

New York: Game or birds taken in the State.

Exceptions: Nonresident may export one deer under his hunting license. Head, feet, and skins of deer legally captured may be exported if carried separately. Deer propagated in inclosed parks may be exported under permit of conservation commission.

North Carolina:[2] Quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach bird, woodcock taken in State.

Exception: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 beach birds or snipe in a season. Export permitted under permit of Audubon Society of ruffed grouse, wild turkey, woodcock, snipe, other shore birds, and nongame birds for propagation.

North Dakota: All protected game, except golden and upland plover, woodcock, and crane.

Exceptions: Nonresident licensee may carry with him from State 2 deer and grouse, prairie chickens, doves, cranes, and swans not exceeding 20 in all, and plover, snipe, ducks, geese, and brant not exceeding 50 in all, open to view, labeled with his name and address and number of his license. Domesticated game may be exported under written permission of board of control.

Ohio: Squirrel, quail, ruffed grouse or pheasant, introduced pheasant, dove, woodcock, plover, snipe, shore birds, rail, coot (mud hen), duck, goose, swan taken in the State.

Exception: Nonresident may take with him from State under his hunting license 50 pieces of game.

Oklahoma: All protected game.

Exception: Nonresident licensee may carry to his home two days' bag limit of game birds.

Oregon: All protected game.

Exceptions: Any citizen of Washington may take one day's bag with him out of the State. Game birds raised in captivity for breeding purposes and pinioned may be shipped with consent of State game warden. Game for propagation or scientific purposes may be exported under permit.

Pennsylvania: All protected game taken in the State.

Exceptions: Nonresident licensee may take with him from the State one day's bag labeled with his name and address and number of his license. Live English, Mongolian, and Chinese pheasants raised in captivity may be exported.

Rhode Island: Quail, ruffed grouse, and woodcock.

Exception: Nonresident may take with him from the State under his hunting license, open to view, 10 wildfowl or birds the export of which is otherwise prohibited by law.

South Carolina: All game birds or animals taken in the State.

Exception: Licensee may carry openly 2 deer, 50 partridges, 12 ruffed grouse, 4 wild turkeys, 50 beach birds, 50 ducks and geese in a season.

South Dakota: All protected game, except woodcock and golden and upland plover.

Exceptions: Two deer. A certificate—good for five days—that such game was lawfully killed must be obtained from a justice of the peace and given to the carrier. Any resident or nonresident may carry out of the State any game bird legally in possession. Game or game birds raised in captivity may be exported under written permission of State game warden.

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[1] Blue Mountain Forest Association permitted to ship deer, elk, and moose killed in its preserve.

[2] Export is also prohibited by the following local laws: *Deer*, Cherokee, Craven, Hyde (Currituck township); *squirrel*, Craven; *quail*, Alexander (for sale—except 50 at one time by nonresident licenses), Catawba, Cherokee, Clay, Cleveland (3 years), Craven, Harnett, Henderson, Iredell, Jackson, Montgomery, Rutherford, Stanly (for sale—except by owner or lessee of land on which killed), Surry (for sale), Swain (live), Union (for sale), Yadkin (for sale); *wildfowl*, Craven (from State), Brunswick (Mar. 10-Nov. 10), Dare (Mar. 10-Nov. 10), New Hanover (Mar. 10-Nov. 10), Stanly (for sale—except by owner or lessee of land on which killed); *other game birds*, Cherokee (pheasant, dove, woodcock, robin, snipe), Craven (wild turkey, dove, woodcock), Montgomery (pheasant, wild turkey, dove), Stanly (all game birds), Tyrrell (woodcock, snipe—unless killed Nov. 1-Feb. 1), Union (dove, lark—for sale).

Export of game prohibited—Continued.

Tennessee: All protected game.

Exception: Nonresident may take with him from the State 50 ducks or 30 pieces of other game, but must present to some officer or employee of common carrier his hunting license and sworn statement that his game will not be sold.

Texas: All wild animals, wild birds, and wildfowl found in the State.

Exception: Nonresident licensee may take with him from the State 3 male deer, 75 ducks (if killed in three consecutive days), and one day's bag limit of other birds, under affidavit that his game will not be sold.

Utah: All protected game.

Exception: Nonresident licensee may take one day's bag out of State under permit.

Vermont: Deer, gray squirrel, quail, ruffed grouse or partridge, plover, English snipe, woodcock, duck, goose.

Exceptions: Nonresident licensee may export 1 deer and one day's bag of game birds under license. Resident may export, open to view, the season limit of game or game birds under his license by having the license marked with shipping point, destination, and number of each kind of game.

Virginia: All protected game.

Exceptions: During open season nonresident may, under his hunting license, take with him out of the State, or as baggage on the same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, and 25 of each, or 100 in all, of plover, snipe, sandpipers, willets, tatlers, and curlew, if killed or captured by himself and shipped open to view and plainly labeled with his name and address. Any citizen of State may ship from the State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, and 12 waterfowl, if open to view and plainly labeled with names and addresses of donor and donee, and number of each kind of bird so shipped.

Washington: All protected game.

Exceptions: Nonresident may export one season's limit of big game and one day's bag limit of birds under his hunting license, if accompanied by affidavit that the game was killed by him and is not for sale. Export of game animals and birds raised in captivity permitted.

West Virginia: All protected game.

Wisconsin: All protected game, except rabbit, squirrel, and coot (mud hen).

Exceptions: During open season nonresident may take out of State under his hunting license, in personal possession or as baggage or express, accompanying same to State line, 1 deer and not more than 30 game animals and birds of all kinds, provided packages are plainly marked so as to show the names and addresses of shipper and consignee and number of each kind of game, and, in case of deer, have proper coupons attached. Park boards allowed to ship, under permit of State game warden, live animals and game birds for park purposes. Shipment allowed of domesticated deer, moose, elk, and caribou, properly tagged, under permit of state game warden.

Wyoming: All protected game.

Exceptions: Smithsonian Institution or other well-known scientific institutions may export any game animals or birds under permit of State game commission.

Export of 1 hide, 1 scalp, 1 head, 1 pair of tusks, 1 skin, 1 mounted head, 1 mounted specimen, of any big game except moose permitted upon affidavit that they were taken from animals lawfully killed, the payment of 25 cents to the justice of the peace of precinct where affiant lives, and attachment of the tag issued by him; a nonresident (or resident, when necessary to cross territory of another State to reach his home) may export under his hunting license 20 dead game birds and the carcass, head, antlers, scalp, skin, and teeth of any animal lawfully killed; exchange of game animals and birds for others for liberation in Wyoming allowed under permit of the State game commission; big game, except moose, captured and held for propagation may be exported after five years.

Alberta: All protected game.

Exceptions: Minister of agriculture on receipt of a $5 fee may grant a permit to export for propagation or scientific purposes one pair of each species of big game and game birds. The lieutenant governor in council may grant permits for a greater number. The Minister of agriculture may also issue permits for export of game for other purposes at the rate of $5 for each head of big game and $1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies, heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 for each head.

British Columbia: All protected game, except bears.

Exceptions: Heads, horns, and skins of big game lawfully killed by the shipper may be shipped under his hunting license and written permission of Minister charged with enforcement of act. Any animal or bird, dead or alive, may be exported for scientific, zoological, or Government purposes under permit of provincial secretary. Live game birds or animals held in captivity under written permission of provincial game warden may be exported.

Export of game prohibited—Continued.

Manitoba: All protected game.

Exceptions: Minister of agriculture and immigration may direct chief game guardian to export not more than 12 animals or birds for propagation and may issue permit to export heads and skins of big game animals, and any game birds, except grouse, prairie chicken, and partridge, but not more than 100 geese and swans or 50 ducks, and these only under nonresident license. (No export of ducks permitted before October 1.) The following export fees are charged: Deer or deer head, $2; head of elk, moose, or caribou, $5; any hide, 10 cents. No export fee required of nonresident licensee.

New Brunswick:[1] All protected game.

Exception: Surveyor general may issue special license to export game alive or dead.

Newfoundland: Caribou (antlers, heads, or skins), or partridge, willow or other grouse for sale.

Exceptions: Minister of marine and fisheries may issue licenses to export caribou for breeding or scientific purposes. Nonresident may export 3 stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit; but not, in either case, for sale.

Nova Scotia: All protected game.

Exceptions: Holder of general license may ship out of Province 1 moose lawfully shot by himself. Mounted heads and dressed skins and live mammals or birds for propagation may be exported under permit from provincial secretary.

Ontario: All wild game animals and birds.

Exceptions: One deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou held by private ownership may be exported.

Prince Edward Island: All game except geese and brant.

Exception: Nonresident licensee may carry out of Province 12 birds killed by himself.

Quebec: Native deer, moose, caribou, or parts thereof, except under permit from Minister of colonization, mines, and fisheries (fee not to exceed $5), or under tags attached to nonresident licenses, and not later than 15 days after close of season.

Saskatchewan: All protected game.

Exceptions: Commissioner of agriculture may grant permits to export for propagation for public parks and zoological gardens or scientific purposes 1 pair of each species of big game and game birds upon payment of $5, or a specified number on application of another Province or State. The holder of a general nonresident license may take with him out of the Province as trophies, heads, skins, and hoofs of big game which he has legally killed.

Yukon: Protected game can be exported by a nonresident only under a hunting license and a shipping permit issued by the commissioner of the Territory.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkeys, quail, partridges, prairie fowl, and woodcock, but permitting each nonresident to export two deer[2] in a year at certain ports within 15 days after the close of the open season, under permit of the collector of customs of the port from which export is made. The ports of export are: Halifax and Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Quebec and Montreal, Quebec; Ottawa, Kingston, Niagara Falls, Fort Erie, Windsor, Sault Ste Marie, and Port Arthur, Ontario; and such others as the Minister of customs may designate.

Those who visit Canada to hunt, camp, etc., must deposit with the customs officer at the port of entry an amount equal to the duty (30 per cent of appraised value) on their guns, canoes, tents, cooking utensils, and kodaks. If these articles are taken out within six months at the same port, the deposit will be returned. But members of shooting or fishing clubs that own preserves in Canada and have filed a guaranty with the Canadian commissioner of customs may present club membership certificates in lieu of making the deposit. They must, however, pay duty on all ammunition and provisions.

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[1] Except in the case of partridge the prohibition applies only to common carriers.

[2] Except from Ontario (see above).

SALE.

Legislation restricting the sale of game is passing through a transition stage. Some States prohibit the sale of game throughout the year, others only in close season, and between these extremes may be found all gradations and exceptions, such as restrictions prohibiting sale of game outside the State or for export, and exemptions allowing sale for a few days in the close season. The difficulty of tabulating such regulations is increased by the fact that in addition to the special sale laws, close seasons and provisions regarding possession must be taken into consideration. In consulting the following summary, therefore, it will be necessary to bear in mind three different classes of restrictions: "Sale in close season," "Sale in open season," and "Sale prohibited all the year."

SALE IN CLOSE SEASON.

In general, the sale of game is prohibited during the close season but a brief additional open period is sometimes provided in order to permit dealers to close out stock on hand at the end of the hunting season. In Colorado, Illinois, Tennessee, and British Columbia the sale season includes the open season and the following five days for all or certain kinds of game. An extension of 10 days for sale is added to the open season in New Brunswick; 15 days in Alaska, New Jersey, and Quebec; 30 days in Pennsylvania; 60 days in Yukon; 3 months (for geese and brant) in New Brunswick; and until the following 1st of January in Ontario.

SALE IN OPEN SEASON.

In order to counteract a tendency on the part of market hunters to anticipate the opening of the season, the sale of certain game is sometimes prohibited at the beginning of the open season, as during the first two days in Illinois, the first three in Nova Scotia, and the first month in British Columbia.

SALE PROHIBITED ALL THE YEAR.

Forty-four States and Territories [1] and most of the Provinces of Canada now prohibit sale of all or certain kinds of game at all seasons. In Alabama, Arizona, Arkansas, Colorado, Idaho, Iowa, Kansas, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Oklahoma, South Carolina, Texas, Washington, and West Virginia the sale, and in Delaware and Nevada the resale, of all protected game is prohibited; in Ohio, of all game except rabbits;

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[1] Omitting Alaska, which prohibits sale only of heads, skins, and trophies and deer in southeastern Alaska to 1912; District of Columbia, which prohibits sale only in close season; North Carolina, which prohibits sale in only a few counties; Georgia, Louisiana, and New Jersey.

in New York of all game except a few imported species; in Wisconsin, of all game except rabbits, squirrels, coots, and rails; in California, Utah, and Manitoba, of all big game and upland game. In a few instances prohibitions against the sale of certain game are so general as to afford protection over a considerable area in adjoining States. Thus, ruffed grouse can not be sold in any State or Province along the Canadian border except Pennsylvania and Quebec. Practically every State in which prairie chickens occur now prohibits their sale or export.

The following statement shows the kinds of game the sale of which is prohibited throughout the year. The sale of all other game is so generally prohibited during the close season as to render a detailed enumeration unnecessary, but when an extension of a few days is added to the open season or a special season is provided for either possession or sale, attention is called to this exemption under the heading "Permitted."

Sale of Game Prohibited Throughout the Year.

Alabama: All protected game.

Alaska: Heads, hides, and skins of all protected game. Deer until 1912.

Permitted: Carcasses of all game may be sold during the open season and 15 days thereafter.

Arizona: All protected game and snipe, rail, duck, goose, and brant.

Arkansas: All "game, wild fowl, or birds whatsoever," except deer raised in captivity, bears, rabbits, opossums, raccoons, and squirrels.[1]

California: Deer meat and hides of female deer, or those from which evidence of sex has been removed all other protected game, except cottontail rabbit, duck, and black brant.

Permitted: Game may be sold under license. Pheasants reared in captivity or imported from foreign country may be sold at any time under permit.

Colorado: All game taken in the State.

Permitted: Domestic game may be sold by hotels, restaurants, etc., during the open season and five days thereafter, or during the limits of a storage permit. Imported game (under license) and game taken from licensed private parks and lakes may be sold at any time if accompanied by an invoice.

Connecticut: Quail, ruffed grouse, Hungarian partridge, woodcock.

Delaware: All protected game, except that resident lawfully taking game may sell plover, snipe, and ducks anywhere and other game in his own county; restaurants buying from such persons may serve game in open season.

Florida: Deer, deer hides, quail or partridge, wild turkey, throughout State; ducks in Brevard and Volusia Counties.

Permitted: In Marion County deer may be sold in open season by a resident to a resident.

Idaho: All protected game.

Illinois: All protected game, except dove.

Permitted: Deer bred in captivity may be sold October 1 to February 1; cock pheasants may be sold by breeders (under permit of State game commissioner) November 1 to February 1; doves may be sold from the third day of the open season to the fifth day of the close season; and legally killed game imported from other States from October 1 to February 1.

Indiana: Quail.

Iowa: All protected game.

Kansas: All protected game.

Permitted: Game reared in captivity may be sold under permit.

Kentucky: Quail, partridge, grouse, pheasant, wild turkey, killed in the State.

Louisiana: Deer.

Permitted: Game birds may be sold during open season, but not later than March 1.

Maine: Deer, moose, or game birds for export. Ruffed grouse, woodcock, ducks, for any purpose.

Permitted: Deer may be sold by local dealers under license, and game birds raised in private preserves maintained under permission of commissioners may be sold without restriction.

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[1] Squirrels killed in Ouachita and Union Counties can not be sold, and no squirrels can be sold in Craighead, Dallas, and Lafayette Counties.

Sale of game prohibited throughout the year—Continued.

Maryland:
Allegany—Deer, quail, grouse, English pheasant, wild turkey, dove, woodcock.
Anne Arundel—All game except squirrel, rabbit, and raccoon.
Baltimore—Partridge, pheasant, woodcock, for export.
Calvert—Rabbit, quail, woodcock, for export for sale.
Cecil—Squirrel, quail, grouse, woodcock, plover.
Frederick—Squirrel, partridge, pheasant, woodcock, taken in county.
Montgomery—Partridge, pheasant, wild turkey, for export.
Somerset—Rabbit, quail or partridge, woodcock, dead or alive, for any other purpose than as food within the county or for propagation; or any game for export.
Washington—Deer, squirrel, rabbit, partridge, pheasant, wild turkey, woodcock.
Wicomico—Quail or partridge for export (from Wicomico and Worcester Counties considered as one territory.)
Worcester—Rabbit, quail, woodcock (except to consumer).
Permitted: Baltimore City—Ruffed grouse may be sold October 1-December 25.

Massachusetts: Deer and quail taken in the State, gray squirrel, ruffed grouse, prairie chicken, sharp-tailed grouse, pheasant, Hungarian partridge, woodcock, piping plover, and killdeer plover.
Permitted: Dealers or persons in the cold-storage business may sell imported quail lawfully obtained during November and December, and may sell at any time hares or rabbits lawfully secured. Live quail for propagation may be sold under permit. Quail and Hungarian partridges raised in captivity under written permit may be sold for propagation. Deer and pheasants raised in captivity may be sold for any purpose.

Michigan: All protected game.
Permitted: Game raised in captivity may be sold alive within State and, under $1 permit, alive or dead without the State.

Minnesota: All protected game.

Mississippi: All protected game.

Missouri: All protected game.
Permitted: Deer or elk reared in captivity may be sold under regulations of commissioner.

Montana: All protected game.

Nebraska: All protected game.

Nevada: Resale of all game.

New Hampshire: Deer (except 2), gray squirrel (to Oct. 1, 1913), ruffed grouse or partridge, woodcock.

New Jersey:
Permitted: All small game may be sold during open season and, if native game, 15 days thereafter.

New Mexico: All protected game except plover, curlew, and snipe.

New York: All game belonging to a family any species or subspecies of which is native to and protected by the State.
Permitted: Deer, elk, pheasants, mallards, and black ducks raised in captivity under license, may be sold under license, September 16-March 2 (deer and elk) and October 1-March 2 (pheasants and ducks); and unplucked carcasses of pheasants, Scotch grouse, European black game, European black plover, European red-legged partridge, and Egyptian quail, and carcasses of imported European deer, fallow deer, and roebuck may be sold September 1-March 2. All must be properly tagged (and, when transported, properly labeled).

North Carolina: Local restrictions in Alexander, Brunswick, Cabarrus, Cherokee, Cleveland, Craven, Harnett, Henderson, Iredell, Mecklenburg, Montgomery (to 1913), Moore, New Hanover, Pender, Randolph, Richmond, Rutherford, Scotland, Stanly, Transylvania, and Union Counties.

North Dakota: All protected game, except woodcock, plover, and crane.
Permitted: Hides of big game lawfully taken may be sold at any time. Domesticated game may be sold on written permission of the game board of control.

Ohio: All protected game, except rabbits.

Oklahoma: All protected game.
Permitted: Domesticated game animals and birds, and heads, hides, and horns of big game lawfully killed may be sold.

Oregon: Deer, elk, moose, sheep, antelope, silver-gray squirrel, quail, bobwhite quail, partridge, Hungarian partridge, English partridge, grouse, ruffed grouse, capercailzie, moor hen, pheasant (silver, golden, copper, green Japanese, Reeves, and ringneck), wild turkey, woodcock, upland plover, rail, duck, swan.
Permitted: Five deerskins, properly tagged, may be sold in a season by the hunter who originally secured them. Tags not issued after first five days of close season. Live ringneck pheasants and other birds raised in captivity for breeding purposes may be sold after being pinioned.

Pennsylvania: Deer, quail, ruffed grouse (pheasant), taken in the State; wild turkey, Hungarian partridge, and woodcock (wherever taken.)
Permitted: Squirrel, rabbit or hare, bear, dove, reedbird, blackbird, upland plover, curlew, tatler, sandpiper, Wilson or jack snipe, or other shore bird, coot or mud hen, rail, duck, goose, brant, swan, loon, and grebe taken in the State, and ruffed grouse taken outside the State, may be sold during the open season and 30 days thereafter. Game or birds used for propagating purposes may be sold at any time under authority of game commissioners.

Sale of game prohibited throughout the year—Continued.

Rhode Island: Quail, ruffed grouse, pheasant, woodcock, plover, yellow legs, peep, snipe, curlew, sandpiper, shore, marsh, and beach birds.

South Carolina: All protected game.

South Dakota: All protected game, except dove, golden and upland plover, and woodcock.

Permitted: Hides, heads, or horns of big game lawfully killed may be sold at any time. Game or game birds raised in captivity may be sold under written permission of State game warden.

Tennessee: Quail, robin. In Dyer County also wild turkey.

Permitted: All game except quail and robin may be sold in the State during the open season and five days thereafter.

Texas: All game animals, hides and horns, wild birds, and wild fowl found in the State.

Utah: Deer, elk, antelope, sheep, quail, partridge, grouse, prairie chicken, sage hen, pheasant, Mongolian, Chinese, and English pheasant, dove.

Permitted: 25 in all of shorebirds and waterfowl may be sold in a day to private parties.

Vermont: All protected game birds.[1]

Virginia: Quail or partridge, grouse or pheasant, robin, woodcock.

Clarke County.—Rabbit, squirrel, wild turkey (outside of county).

Frederick, Shenandoah counties.—Wild turkey (prohibition applies only to nonresidents of Virginia).

Washington: All protected game.

Permitted: Hides and horns of big game legally killed, and propagated game animals and birds may be sold for propagation purposes at any time.

West Virginia: All protected game, except reedbird and rail.

Wisconsin: All protected game, except rabbit, squirrel, coot (mud hen), and rail.

Permitted: Domesticated deer, moose, elk, and caribou may be sold under permit of State fish and game warden.

Wyoming: Deer, elk, moose, antelope, sheep, or any head, hide, scalp, tusk, carcass, or part of carcass thereof, mounted specimens of game or birds, and skins of birds.

Permitted: Sale of 1 live game animal, 1 skin, 1 mounted head, 1 mounted specimen, 1 pair of tusks, 1 hide, 1 scalp, and 1 head of any big game, except moose, on affidavit that they were lawfully captured or were taken from animals lawfully killed and payment of 25-cent fee to the justice of the peace of precinct where affiant lives and attachment of tag issued by him. Sale of the natural increase of any big game, except moose, captured and held for propagation.

Alberta: All protected game.

Permitted: The flesh of big game and game birds may be sold at any time under $10 license. Heads of big game before being sold must be stamped by Minister of agriculture at fees of $5 for elk, caribou, moose, and sheep, and $2 for deer, antelope, and goat.

British Columbia: Elk, quail, grouse, ptarmigan, prairie chicken, English partridge, pheasant, swan, female and young of deer, moose, caribou, or sheep, heads of moose, caribou, and sheep.

Permitted: Male deer may be sold September 1-November 16; male moose, caribou, sheep, goats, and hares after October 1; snipe, ducks, and geese, October 1-December 1; and plover during the open season and five days thereafter. Lieutenant governor in council may alter or extend sale seasons.

Manitoba: Deer, elk, moose, caribou, antelope (except heads and hides), quail, grouse, pheasant, partridge, prairie chicken, woodcock, plover, snipe, sandpiper. Ducks can not be sold before October 1.

Permitted: Possession of grouse, prairie chickens, and partridges allowed for forty-five days, and ducks for three months, after close of hunting season. Deer for private use may be possessed at any time on proof of legal killing.

New Brunswick: Partridge and woodcock to September 15, 1912.

Permitted: Geese and brant during open season and until March 1, and other game during open season and (under license) ten days thereafter. Keepers of hotels, inns, boarding houses, or restaurants may serve game during open season and fifteen days thereafter. Surveyor general may issue $1 licenses to dealers permitting sale by each of 3 deer and heads of same to taxidermists, and licenses to deal in hides or skins of game animals with fees of $25 to nonresidents or aliens and $2 to residents.

Newfoundland: Capercailzie, black game.

Permitted: Caribou may be sold from August 1 to January 1.

Nova Scotia: Deer, caribou to 1912, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge.

Permitted: Moose may be sold from September 16 to December 1. Any game bird other than those above mentioned during the open season with the exception of the first three days.

Ontario: Quail, partridge, woodcock, snipe, subject to regulations of Lieutenant governor in council.

Permitted: All other native game may be sold during the open season[2] by the person killing it and by dealers during open season and until the following January 1 under license. Imported game may be sold under special regulations and licenses.

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[1] Game from private game preserves stocked at owner's expense may be sold at any time.

[2] Seasons depend on regulations of game commission.

Sale of game prohibited throughout the year—Continued.

Quebec:[1] Birch or swamp partridge, until October 1, 1912.

Permitted: All other game may be sold during the open season and fifteen days after the close thereof. Hotels, restaurants, and clubs may serve, under license, all game lawfully taken, except birch or swamp partridge. Live animals, and skins and heads of animals lawfully taken, may be sold.

Saskatchewan: Sheep, goat, or prairie chicken, grouse, pheasant, ptarmigan, or other member of the Gallinæ.

Yukon:

Permitted: Deer, elk, moose, caribou, bison, musk oxen, sheep, and goats may be sold during the open season and sixty days thereafter.

LIMITS.

Laws limiting the amount of game which can be killed in a day or a season are now in force in 46 States and 10 Canadian Provinces. These measures are of comparatively recent origin. One of the first statutes of the kind was that passed in Iowa in 1878 (ch. 156, sec. 3) limiting the killing or possession of prairie chickens, snipe, woodcock, quail, and ruffed grouse to 25 in a day.[2] Maine, in 1883 (ch. 185, sec. 1), limited the number of big game which an individual might kill in a season to 1 moose, 2 caribou, and 3 deer, and New York, in 1886 (ch. 194, sec. 1), likewise limited the number of deer to 3. In spite of the objection often urged against such statutes—that they are impossible of enforcement and easily evaded—experience has shown them to constitute one of the most effective features of modern game legislation. They have been tested in the courts and upheld by the supreme courts of several States, notably those of Maine and Wisconsin.[3]

When restrictions on limits are extended to possession and shipment as well as killing, and the total amount of game allowed a party made less than the quantity allowed the individual members of the party, little difficulty is experienced in enforcing the statute. Moreover, among law-abiding sportsmen the incentive to make large bags is removed when the act is declared illegal.

In recent years bag limits have been materially reduced, and only a few States now allow more than 2 deer a season or 1 head of other big game, while the usual limits per day in the case of birds are 10 grouse or woodcock, 15 quail, and 25 waterfowl. In Canada, where the country is not so closely settled, bag limits on most game are fewer and more liberal than in the United States.

Limits fixed by Law for the Capture of Game.

Alabama: One deer, 2 turkeys, 25 of each other kind of birds a day.

Alaska: Eight deer, 2 moose, 3 each of caribou, sheep, and brown bears a season; 25 grouse, ptarmigan, shore birds or waterfowl a day.

Arizona: Three deer a season, 25 quail a day.

Arkansas: No limits, except in the following counties: Deer, Bradley 3, Dallas 3, Desha 4, Phillips 4 (or 1 for each member of party), Chicot 5, a season; quail, Bradley and Dallas 300 a season or 25 a day for each member of party.

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[1] Lieutenant governor in council may prohibit sale of any game for three years or less or prolong any existing period of prohibition for three years or less.

[2] This statute was, however, preceded by one enacted in 1874 limiting the shipment of game birds to one dozen a day, provided the birds were not shipped for sale (ch. 69, sec. 1).

[3] See Allen *v.* Leighton, 32 Atl., 877 (Maine, 1895); State *v.* Nergaard, 102 N. W., 899 (Wisconsin, 1905).

Limits fixed by law for the capture of game—Continued.

California: Two deer, 12 tree squirrels a season; 15 cotton-tail or brush rabbits, 4 grouse, 4 sage hens, 10 mountain quail, 20 each of desert or valley quail, doves, plover, curlew, snipe, or other shore birds, and ibises, and 25 ducks and black sea brant a day; 50 ducks or black sea brant per week.

Colorado: One deer a season; 20 game birds a day, 30 in possession at one time. Persons under 12 years of age limited to half this number of birds.

Connecticut: Five each of quail and ruffed grouse a day, 36 a year; 35 rail, 50 each of plover, snipe, shore birds a day.

Delaware: Six animals, 75 rail, 20 ducks, 12 other birds or fowl, except plover, snipe and reedbirds, a day.

District of Columbia: No limits.

Florida: Five deer, 5 turkeys a year; 20 quail, 2 turkeys by individual, or 40 quail, 4 turkeys by party a day.

Exceptions.—De Soto County, 10 turkeys, 10 quail a season. Lee County, 10 turkeys a season; 15 quail a day; party of 2 or more, 30 a day. Marion County, 3 deer, 3 turkeys a season; 1 deer, 15 quail, 1 turkey a day or in possession at one time; parties of 2 or more limited to 2 deer, 30 quail, 2 turkeys a day.[1] Brevard and Volusia Counties, on Indian River, Mosquito lagoon, and Indian River north, 25 ducks a day.[1]

Georgia: Forty doves a day.

Idaho: Two deer, 1 elk, 1 ibex, 1 goat, 1 sheep a season; 18 quail, 12 each of partridges, sage hens, grouse, pheasants, 24 doves, plover, snipe, ducks, 4 geese, 1 swan a day; not more than 24 of all kinds in possession at one time.

Illinois: Fifteen squirrels, 12 quail, 3 prairie chickens, 15 doves, 15 shore birds, 15 coots, 15 rail, 15 ducks, 10 geese, 10 brant, 15 other waterfowl a day.

Indiana: Fifteen quail, 15 ducks or other waterfowl a day; 45 birds in possession as result of 3 or more days' consecutive hunting.

Iowa: Twenty-five each of all animals, birds, and game a day; 50 ducks in possession at one time.

Kansas: Twenty each of quail, prairie chickens, plover, snipe, duck; 6 each of geese and brant a day.

Kentucky: No limits.

Louisiana: Two deer a day (3 to a party of 3 or more), 5 a season; 1 turkey cock, 25 ducks or poule d'eau, 15 other game birds a day.

Maine: One moose, 2 deer a season (except in Cumberland, Knox, Kennebec, Lincoln, Sagadahoc, Waldo, and York Counties, limit 1, and in lumber camps, limit 6); 5 ruffed grouse, 10 woodcock, 15 each of plover, snipe, and ducks, and 70 sandpipers a day.

Maryland: One deer a season; 12 rabbits, 12 squirrels, 15 quail (partridges), 6 ruffed grouse (pheasants), 3 English pheasants, 2 wild turkeys, 25 doves, 12 woodcock, 12 jacksnipe a day; 50 rail (ortolan) per tide.

Exceptions.—Calvert, 12 quail, 6 rabbits a day. Cecil, 12 quail (partridges), 4 ruffed grouse (pheasants), 15 snipe, 50 rail (ortolan), 50 blackbirds per day. Patuxent River, 75 rail (ortolan) or reedbirds a day.

Massachusetts: One deer in counties having open season, 15 black ducks a day.

Michigan: Two deer, 50 each of quail, partridges, spruce hens, woodcock, plover, 50 in all of snipe and other shore birds a season; 10 quail a day, 15 in possession at one time; 6 in all of partridges and spruce hens a day, 15 in possession; 6 woodcock, 10 plover a day, 20 each in possession; 10 in all of snipe and other shore birds a day, 20 in possession; 25 in all of ducks, geese, and brant a day or in possession at one time.

Minnesota: One deer, 1 moose a season, 15 birds a day; 45 quail, partridges, ruffed grouse, pheasants, prairie chickens, white-breasted or sharp-tailed grouse, doves, plover, woodcock combined; 50 snipe, duck, goose, brant, any aquatic fowl combined, in possession at a time.

Mississippi: One deer a day, 5 a season; 20 each of quail, wild turkeys, plover, tatlers, chorooks, grosbecs, coots, poules d'eau, rails, ducks, geese, brant, swans a day.

Missouri: One deer, 2 turkeys, 25 of any other species a day; or 2 deer, 4 turkeys, 50 of any other species in possession at a time.

Montana: Three deer, 1 elk, 1 goat, 1 sheep a season; 5 each of grouse, partridges, prairie chickens, fool hens, pheasants, sage hens, and 20 ducks a day.

Nebraska: Ten squirrels, 10 quail, 10 prairie chickens or grouse, 10 wild geese or brant, and 25 game birds of any other variety a day; 20 squirrels, 10 prairie chickens or grouse, 10 wild geese or brant, or 50 other game birds in possession at one time.

Nevada: Two deer a season; 15 mountain quail, 15 valley quail, 10 sage hens, 6 grouse, 5 plover, and 15 snipe, 20 ducks, 10 geese, 3 swans a day.

New Hampshire: Two deer a season in Coos, Carroll, and Grafton Counties, 1 in rest of State.

New Jersey: One deer a season; 10 quail, 3 ruffed grouse, 3 English or ringneck pheasants, 3 Hungarian partridges, 10 woodcock, 30 each marsh hens and ducks, 15 each geese and brant a day or in possession. (Not applicable to dealer in game, hotel keeper, etc., during open season at place of business.)

New Mexico: One deer a season; 2 wild turkeys a day, 4 in possession at one time; 6 grouse a day or in possession at one time; 20 ducks a day, 30 in possession at one time; 30 other birds a day or in possession at one time.

New York: Two deer, 36 quail, 36 woodcock, 20 grouse, 3 male imported pheasants a season; 10 rabbits, 6 quail, 6 woodcock, 4 grouse a day.

Limits fixed by law for the capture of game—Continued.

North Carolina: Brunswick, New Hanover, Pender, 15 marsh hens a day; Buncombe, 2 deer a season, 25 partridges, pheasants, wild turkeys, or doves a day; Cabarrus, Mecklenburg, Surry, 15 quail (partridges) a day; Cleveland, 10 quail (partridges) a day; Dare, 5 deer a season; Haywood, 1 buck a day, 2 a season, 2 pheasants, 2 wild turkeys, or 20 birds in all, a day; Henderson, Jackson, 2 bucks a season; Madison, 25 birds a day; Transylvania, 3 deer a season, 5 squirrels, 20 quail (partridges) a day.

North Dakota: Two deer a season; 10 prairie chickens, grouse, cranes, combined a day, 20 in possession at one time; 25 plover, snipe, woodcock, ducks, geese, brant combined, 50 in possession at one time.

Ohio: Five squirrels, 12 each of quail, doves, plover, snipe, woodcock, shore birds, rail, geese, 25 ducks a day.

Oklahoma: One deer a season; 1 turkey (male) March 15–April 15, 3 turkeys, November 15–January 1, 25 quail, plover, curlew, snipe, other shore birds, or ducks a day, 150 a season; 15 prairie chickens a day; 100 a season, 10 geese or brant a day; 1 swan a season.

Oregon: Five deer a season; 5 each of quail, prairie chickens, sage hens a day, 10 a week (10 quail a day, 20 a week, in Jackson and Josephine Counties); 5 grouse, ruffed grouse, partridges a day, taken collectively, 10 a week; 50 shore birds, 25 ducks a week.

Pennsylvania: One deer a season; 6 squirrels, 10 rabbits or hares a day; 10 quail a day, 40 a week, 75 a season; 5 ruffed grouse a day, 20 a week, 50 a season; 10 each of English, Mongolian, or Chinese pheasants and woodcock a day, 20 a week, 50 a season; 5 Hungarian partridges a day, 20 a week, 30 a season; 1 wild turkey a day, 2 a season. Possession limited to season's limit.

Rhode Island: No limits.

South Carolina: Five deer a season, 25 quail (partridges), 2 wild turkeys, 25 doves, 12 woodcock, a day.

South Dakota: One deer a year; 20 waterfowl, 10 other birds a day; 25 partridges, ruffed grouse, prairie chickens, sharp-tailed (white-breasted) grouse, pheasants, woodcock, golden plover and upland plover, in aggregate in possession at one time; 50 snipe and waterfowl in aggregate in possession at one time.

Tennessee: Fifty ducks; 30 of all other birds in aggregate a day.

Texas: Three deer a season; 25 birds a day (3 wild turkeys December to February).

Utah: One deer a season (residents only), 15 quail, 8 sage hens, 25 doves a day or in possession at one time, 5 in all of geese, brant, and swans a day, and 25 in all of snipe, shore birds, ducks, geese, brant, swans a day (having more than 25 in possession at one time prima facie evidence of violation of law).

Vermont: One deer and 25 ruffed grouse or woodcock a season; 6 rabbits, 5 each of gray squirrels, quail, ruffed grouse, partridges, plover, English snipe, woodcock, and geese, and 20 ducks a day.

Virginia: No limits.

Washington: Two deer, 2 sheep, 2 goats, 1 moose, 1 antelope, 1 caribou, a season; 5 in all of partridges, grouse, prairie chickens, and pheasants, 10 quail a day; 20 in all of snipe, ducks, geese, and brant a day or 50 a week. If the bag of upland game birds includes quail, the limit is 10 a day or 30 a week.

West Virginia: Two deer a season; 12 quail a day, 96 a season; 6 ruffed grouse a day; 25 a season; 2 wild turkeys a day, 6 a season.

Wisconsin: One deer a year; 5 grouse, prairie chickens, woodcock, 10 partridges, 15 plover, snipe, coots, rail, rice hens, ducks, 10 geese or brant, a day; 20 of all kinds of birds in possession by resident in one day.

Wyoming: Two deer, 2 elk (1 additional by resident under special license), 1 sheep a season; 18 birds (of which not more than 12 may be grouse) a day, or in possession at one time.

Alberta: One deer, 1 moose, 1 caribou, 2 antelope, 2 sheep, 2 goats a season; 20 grouse, partridges, pheasants, prairie chickens, ptarmigan a day, or 200 a season.

British Columbia: Five deer, 2 elk, 2 moose (1 in county of Kootenay), 3 caribou, 3 goats, 2 sheep (1 in county of Kootenay), 250 ducks and snipe a season. (Nonresident licensee may kill 5 deer, caribou, and goats, but not more than 3 of any one species, and 3 moose, elk, and sheep, but not more than the bag limit of any one species.)

Manitoba: One in all of deer, elk, moose, caribou, and antelope a season; 20 in all of grouse, partridges, prairie chickens a day, 100 a season; 20 ducks a day in September, 50 ducks a day in October and November.

New Brunswick: Two deer, 1 moose, 1 caribou a season (lumber camp limited to 2 moose, 2 caribou a season); 10 partridges, 10 woodcock, 20 ducks a day.

Newfoundland: Three caribou a season.

Nova Scotia: One moose a season; 5 ruffed grouse, 15 woodcock a day.

Ontario: One deer, 1 moose, 1 caribou a season. Two or more persons hunting together under license may kill an average of 1 deer each.

Prince Edward Island: No limits.

Quebec: Zone 1: Two deer, 1 moose, 2 caribou a season. Zone 2: Two deer, 1 moose, 4 caribou a season.

Saskatchewan: Two deer, 2 elk, 2 moose, 2 caribou, 2 antelope a season; 10 grouse, partridges, pheasants, prairie chickens, ptarmigan a day, or 100 a season.

Yukon: Six caribou or deer, 2 moose, 2 elk, 2 sheep, 2 goats, 2 musk oxen a season.

LICENSES FOR HUNTING AND SHIPPING GAME.

In Arkansas nonresidents are not permitted to hunt, except on their own premises,[1] and in all the States except Delaware and Georgia and throughout Canada licenses must be secured before nonresidents can hunt any or certain kinds of game (see fig. 2, p. 44). In 33 States and 6 Canadian Provinces a like restriction is imposed on residents, but the fees are usually much smaller, and often are merely nominal (see fig. 1, p. 44). The fees for nonresident licenses for both big and small game range from $10 in a number of States to $50 in Alaska, Wyoming, New Brunswick, Newfoundland, Ontario, and Saskatchewan, and $100 in British Columbia and Yukon; those for resident licenses from 50 cents in Vermont to $5 in Missouri, South Dakota, and Washington, and $7 ($5 for moose and caribou and $2 for deer) in Ontario.

A special kind of hunting license, often known as the "alien" license, is being generally adopted to restrict hunting by persons who are not citizens of the country, and is now in force in about half of the States. Louisiana, Maine, Massachusetts, Connecticut, and Rhode Island have special $15 licenses for resident aliens; Washington, Wyoming, and Manitoba a $50 license for nonresident aliens; California, Idaho, Montana, Nevada, and Oklahoma a $25 license; Utah and Alaska a $100 license for all aliens, and Pennsylvania prohibits aliens from hunting or owning guns in the State.

Licenses are generally issued only for the open season, and thus expire at fixed dates. Some are necessarily very brief in duration. Michigan issues a $25 nonresident deer license good only for 25 days of season. In a few instances licenses are issued at reduced rates for a week or for a few days. Of this character are the nonresident bird licenses, good for one week, issued by Colorado and to British subjects by British Columbia; the 6-day bird license issued to nonresidents in Saskatchewan; the guest license good for five days, issued by Alberta and the daily licenses issued for hunting birds in Colorado and any game in Lafayette, Marion, and Sumter Counties, Fla.

Landowners or taxpayers are not required to pay the usual fee in a number of States, and no license is required of those hunting in their own county in Texas or Nova Scotia. Special exemptions are made in favor of nonresident members of fish and game clubs by Massachusetts, Rhode Island, and Quebec. In Virginia no license is required of bona fide guests of residents, and in Ontario no fee is charged for a guest license.

In Maine,[2] South Dakota, Wyoming, New Brunswick (on wild lands), and Nova Scotia nonresidents are not permitted to hunt big game unless accompanied by qualified guides. Nearly every State requires licensees to have their licenses in personal possession while

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[1] Except in a few counties.

[2] On wild lands of the State, except from December 1 to 15.

MAPS SHOWING LICENSE LAWS IN 1911.

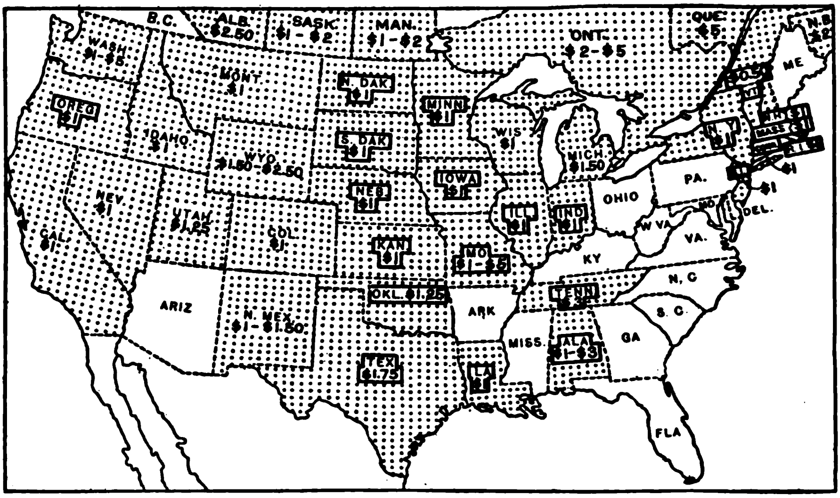

FIG. 1.—States and Provinces which require residents to obtain hunting licenses.

Inclosed names indicate States which permit residents to hunt on their own land without license. Nova Scotia has a $5 resident license and exempts landowners.

Note that many of the States adopt the French method of exempting landowners, while some, particularly in the West, follow the English method of requiring everyone who hunts to obtain a license.

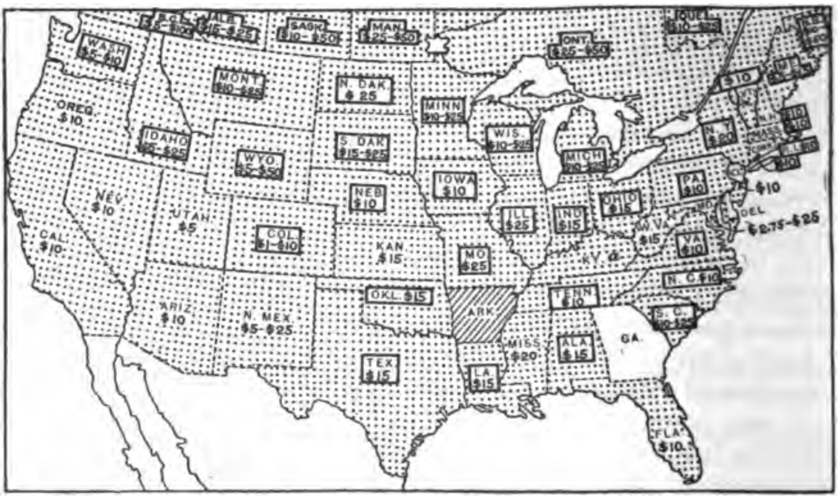

FIG. 2.—States and Provinces which require nonresidents to obtain hunting licenses.

Inclosed names indicate the States which specifically permit licenses to take a limited amount of game out of the State. Alaska and Newfoundland have $50, Nova Scotia $30 and $15, and Prince Edward Island $15 nonresident licenses, with export privileges. Arkansas does not permit hunting by nonresidents, except in a few counties. Kentucky, marked *a*, has no definite fee. (For details, see pp. 45–52.)

hunting and to exhibit them on demand of any warden (in New Hampshire, New York, and Iowa of any person).

In Alberta the resident big game license is not required in the northern part of the Province. In Newfoundland free hunting licenses are granted to officers of British war ships stationed on the coast for the protection of fisheries. Officers of the army or navy stationed in Nova Scotia, nonresident landowners paying taxes to the amount of $30 or more annually in Nova Scotia, and nonresidents owning real estate in Prince Edward Island to the value of $325 and paying taxes thereon, are required to pay fees of $5 only. In Ontario the lieutenant governor in council is authorized to reduce nonresident license fees to the amount charged residents of Ontario by the Province of which applicant is a resident; and farmers living on their own land in districts of Haliburton, Muskoka, Parry Sound, Nipissing, Algoma, Thunder Bay, and Rainy River may each take one deer a season for their own use without being required to secure the prescribed resident license. In Quebec, in discretion of the Minister of colonization, mines, and fisheries, poor Indians or settlers may not be compelled to take out the $5 resident license required for an additional number of deer and caribou.

Details in regard to hunting licenses are given in the table following. In every case the fee includes the amount charged for issuing the license. The term commissioner unless otherwise qualified means the game or fish commissioner.

Details of hunting licenses and export regulations.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Export limit.
Alabama	Nonresident	$15.00	Probate judge	Expires Dec. 31	Game lawfully killed by licensee.
	Alien	15.00	do	do	
	Resident	3.00	do	State license; required outside of county of residence, except on lands owned or leased by hunter.	
	do	1.00	do	County license; not required on lands owned or leased by hunter. Expires Dec. 31.	
Alaska	Nonresident	50.00	Governor	Expires Dec. 31	2 moose (north of lat. 62°), 4 deer, 3 caribou, 3 sheep, 3 goats, and 3 brown bears.
	Alien (nonresident)	100.00	do	do	
	Guide		do	American citizen or native of Alaska. Fee fixed by governor.	
	Shipping (resident)[1]	40.00	do	Export of heads or trophies by resident	1 moose (north of lat. 62°), 4 deer, 2 caribou, 2 sheep, 2 goats, and 2 brown bears.
	do	10.00	do	do	1 caribou or sheep.
	do	5.00	do	do	1 deer, goat, or brown bear.
	Shipping (special)[1]	150.00	do	Export of moose from southern Alaska	1 moose, south of lat. 62°.
Arizona	Nonresident	10.00	Commissioner or county recorder.	Deer only	No export.
Arkansas				Nonresidents not permitted to hunt[2]	No export.
California	Nonresident	10.00	Fish commissioner, county clerks.	Expires June 30	No export.
	Alien	25.00	do	do	
	Resident	1.00	do	do	
Colorado	Nonresident or alien	10.00	Commissioner or county recorder.	Expires Dec. 31	Permit required from commissioner.
	do	2.00	do	County license for birds, good for 1 week	
	do	1.00	do	County license for birds, good for 1 day	
	do	12.00	do	Hunting and fishing license. Expires Dec. 31	
	Resident	1.00	do		
	Guide	5.00	Commissioner	Must also have State license.	
Connecticut	Nonresident	10.25	City or borough clerk	Expires Dec. 31	No quail, ruffed grouse, or woodcock.
	Alien	15.25	do	do	
	Resident (citizen)[3]	1.25	do	do	
Florida	Noncitizen[4]	10.00	Clerk of circuit court	County license. Expires Mar. 1	No deer, quail, or wild turkeys.
Georgia[5]	Market hunting	25.00	Ordinary of county	County license. Expires Dec. 31	No quail.
Idaho[6]	Nonresident or alien	25.00	Warden, and deputies	Expires Mar. 31	2 deer, 1 ibex, 1 mountain goat, 1 mountain sheep, 1 elk. No birds.
	do	5.00	do	Birds only	
	Resident citizen	1.00	do	Hunting and fishing. Not required of women	
Illinois	Nonresident	25.50	City or county clerk	Expires June 1	Not more than 50 birds of all kinds.
	Resident	1.00	do	Not required of owners and tenants of farms hunting on their lands.	
Indiana	Nonresident	15.50	Clerk of circuit court	Good for 1 year	Nonresident: 15 birds of all kinds, or 45 in case of 3 or more days' consecutive hunting. Resident: No export.
	Resident	1.00	Commissioner, clerk of circuit court.	Not required of landowners hunting on their own lands, nor of their children or tenants, nor for hunting rabbits in township of residence.	

Iowa	Nonresident	10.50	County auditor	Expires July 1	25 of all kinds of game.
	Resident	1.00	do	Not required of owners or tenants of farm lands, or their children, hunting on such lands.	
Kansas	Nonresident	15.00	Secretary of state	Not required of landowners hunting on their own premises. Expires June 30.	No export.
	Resident	1.00	County clerk	do	
Kentucky	Nonresident		do	Fee charged nonresident in State of applicant. Expires 1 year from date of issue.	No quail, grouse, pheasant, wild turkey.
Louisiana	Nonresident or alien	15.00	Tax collector	County license. Fee $5 if licensee hunt on his own land. Good for season.	Nonresident: 1 male wild turkey, 25 ducks or rail, and 15 other birds. Resident: No export.
	Market hunting	10.00	do	Issued to residents only	
	Resident	1.00	do	State license. Not required of person hunting on his own land.	
Maine	Nonresident	15.00	Commissioners	All game during October, November, and December	Nonresident: 1 moose, 2 deer, 10 each of partridges, ducks, and woodcock. Resident: No export.
	do	5.00	do	Game that may be shot before Oct. 1. Holder may obtain big-game license by paying $10 additional.	
	Alien	15.00	do	Not required of aliens who pay taxes or who have resided in State 2 years continuously prior to 1907.	
	Camp keeper	5.00	do		
	Guide (nonresident)	20.00	do	Expires Dec. 31. Guide to be registered, and to guide not more than 5 persons at a time.	
	Guide (resident)	1.00	do	do	
	Shipment		do	Moose, $5; deer, $2; one pair of game birds a month, 50 cents.	
Maryland	Nonresident [6]	$5.00 25.50	Clerk of circuit court [7]	Separate county laws	Local laws.

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[1] Not more than one general ($40) license and two special ($150) moose licenses issued to one person in one year. Each shipper must file with customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.

[2] But see State *v.* Mallory, 83 S. W., 955, deciding that nonresidents may hunt on their own land. A few counties make exceptions, as follows: Western district of Clay County, $15.50; Stone County, $5; Chicot County, $5 (or $2 if invited by licensed resident); Bradley and Dallas Counties for hunting and fishing, $1.50 (if invited by licensed resident); and in Desha and Phillips Counties on such invitation without a fee, but in Phillips County the host is limited to three guests at one time. Residents are required to obtain licenses in the following counties: Phillips, Bradley, Dallas, $1.50; Chicot, Desha, $2.

[3] No license is required of a bona fide resident of Connecticut, or his lineal descendants, hunting on land occupied by him and used for agricultural purposes.

[4] Not applicable to counties having special game laws. Nonresidents of Lafayette and Sumter Counties required to secure license of game warden and pay therefor $1 per day. Clay County issues a $10 guide license. No one is permitted to hunt in Taylor County who is between the ages of 18 and 60 and does not pay taxes or work on the roads in the county, nor in Wakulla County if between the ages of 21 and 55 and not a taxpayer of the State. Lake and Levy Counties require noncitizen to secure $10 license, good Nov. 15–Feb. 15. Marion issues a 10-day $5 license to residents of State who are nonresidents of county; on three days' notice to game warden license may be used longer if holder pays fee of $1 per day; no license required of club members hunting on club's premises. De Soto County issues a $1 resident license and a $50 nonresident (of county) license. Lee County requires a $25 license of nonresidents of State, and provides that any person acting as guide shall take oath to faithfully observe game laws and report any violations.

[5] Not required of veterans of the Civil War.

[6] County and local licenses are issued at the following rates, including clerk fees: Allegany, $10.50; Baltimore, resident of State, $5.25, nonresident of State, $10.25 (rabbit, squirrel, quail, grouse, jacksnipe); Calvert, $10.50; Caroline, $5; Carroll, $10.50; Cecil, $10 (rabbit, quail, grouse, woodcock, blackbird, reedbird, rail, plover, and crowbill, teal, mallard, sprigtail, black, and summer ducks); Charles, $20.50 (rabbit, quail, and woodcock); Dorchester, $5; Frederick, $15.50; Garrett, $25.50; Harford, $10.50 (all game except waterfowl); Howard, $8; Kent, $15.50, $5.50 if invited by landowner (all game except waterfowl); Montgomery, $15.50; Patuxent River, $11 (club license $50); Prince George, $20.50 (upland game); Queen Anne, $4.50; St. Mary, $20.50 (upland game); Somerset, resident of State, $2.75, nonresident of State, $10.50; Talbot, $10 (upland game); Washington, $10.50 (not required if written permission be secured from landowner or lessee); Wicomico, $10.50; Worcester, $10 (wild fowl). Guests of landowners require no license, except in Allegany, Baltimore, Caroline, Dorchester, Garrett, Kent, Somerset, Talbot, and Worcester Counties. (Dorchester grants the privilege if the nonresident be a relative of his host.) Anne Arundel prohibits hunting by nonresidents of the county except by permission of landowners, and Charles prohibits hunting of waterfowl by nonresidents. In several counties residents pay special licenses as follows: Baltimore, $1.25 (rabbit, squirrel, quail, grouse, jacksnipe); Anne Arundel, pusher, $2, booby and brush blind (west side of Chesapeake Bay), $5 (South River), $2.50; Cecil (on Bohemia and Elk Rivers), sneak boat, $5.50 (on Bohemia, Elk, and Sassafras Rivers), sink box, $10.50; Harford, sneak boat, $5.75, sink box, $20.75; Patuxent River, pusher, $2.50; Queen Anne, booby blind, $2.50, sink box, $5.50; Susquehanna Flats, sneak boat, $5.75, sink box, $20.75.

[7] In Cecil County by the Cecil County Game Protective Association.

[8] Georgia has just adopted a $15 nonresident, $3 State, and $1 county license.

Details of hunting licenses and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Export limit.
Massachusetts [1]	Alien	$15.00	City or town clerk	Required of unnaturalized foreign-born residents	6 birds.
	Nonresident	[2] 10.00	Commissioners	Expires Dec. 31	
	Resident	1.00	City or town clerk	Not required of persons hunting on land which they own or on which they live.	
Michigan	Nonresident	25.00	County clerk	Deer. Good for 25 days	1 deer under shipping permit; 1 day's bag limit.
	do	10.00	do	Small game only. Not required of persons hunting on their own lands.	
	Resident	1.50	do	Deer. Good for season	
	Export	10.00	State warden		Nonresident landowner and member of a club maintaining a game preserve may export 20 ducks or migratory birds killed by him on said premises.
Minnesota	Nonresident	25.00	Commissioners	Game animals. Expires Dec. 31	1 deer, 25 birds.
	do	10.00	do	Game birds	
	Resident	1.00	County auditor	Deer and moose. Expires Dec. 31	
	do	1.00	do	Game birds. Not required in county of residence. Expires Dec. 15.	
Mississippi	Nonresident	20.00	Sheriff	County license. Landowners and their nonresident relatives and friends hunting on their lands exempt. Good for season.	No export.
Missouri	do	25.00	Commissioner	Expires Dec. 31	2 deer, 4 turkeys, 50 of other species.
	Resident	5.00	County clerk or license collector.	State license. Expires Dec. 31	
	do	1.00	do	County license. Required for hunting in county of residence or in adjoining counties. Not required of owners or tenants of farm lands hunting on such lands. Expires Dec. 31.	
Montana	Nonresident or alien	25.00	Warden	Hunting and fishing. Expires Dec. 31	Number permitted to be killed (see p. 41).
	do	10.00	do	Hunting and fishing. Birds only	
	Resident [3]	1.00	Warden or justice of peace		
	Guide	10.00	Warden	Good for 1 year	
	Shipping	.50	do	Permits limited export in open season	50 birds.
Nebraska	Nonresident	10.00	Commissioner or county clerk.	Hunting and fishing. Expires Dec. 31	
	Resident	1.00	do	Hunting and fishing. Not required of boys under 18 accompanied by parents or guardians, or of persons hunting on lands they own or occupy.	
Nevada	Nonresident	10.00	County clerk or warden	Not required of women, of children under 14, or of persons hunting on their own lands.	No export.
	Alien	25.00	do	Good for 1 year	
	Resident	1.00	do	do	
New Hampshire [4]	Nonresident or alien	10.00	Commissioners	Expires Dec. 31. Not required of landowner (or immediate family) hunting on his own land.	2 deer, 12 birds.
	Resident [3]	1.00	do		
	Guide	1.00	do	Resident. Expires Dec. 31	
	do	20.00	do	Nonresident. Expires Dec. 31	

New Jersey	Nonresident	10.50	County clerk	Expires Dec. 31	10 rabbits and 15 birds a day.
	Alien	10.50	County, city, or town clerk.	Not required of owner or lessee of farm land hunting on land on which he resides.	
	Resident citizen	1.15	do	Not required of landowner or members of family residing on his land and hunting thereon.	
New Mexico	Nonresident	25.00	Warden or deputy	Big game	Under permit.
	do	5.00	do	Game birds, except turkeys	
	Alien	10.00	do	do	
	Resident alien	5.00	do	do	
	Resident	1.50	do	General	
	do	1.00	do	Big game, including turkeys	
	do	1.00	do	Game birds, except turkeys	
	Guide	5.00	do		
New York	Nonresident	20.50	County, city, or town clerk	Expires Dec. 31. Alteration of license a forgery	1 deer.
	Alien	20.50	do	do	
	Resident	1.10	do	Alteration of license a forgery. Not required of owner or lessee (or immediate family) occupying and cultivating farm land and hunting on such land.	
North Carolina	Nonresident (Audubon).	10.25	Clerk of superior court	Good only in 37 counties not covered by following and 3 local licenses. Not required of parents and children of landowners hunting on their grounds.	50 partridges or quail, 12 grouse, 2 turkeys, 50 beach birds or snipe.
	Nonresident (special).[5]	10.50	do	Good only in county of issue	
North Dakota	Nonresident	25.00	County auditor	Expires Dec. 15	Nonresidents only. 2 deer; 20 (in all) of grouse, prairie chickens, doves, cranes, and swans; 50 (in all) of plover, snipe, ducks, geese, and brant. Resident; no export.
	Resident [6]	1.00	do		
Ohio	Nonresident	15.25	County clerk	Expires Dec. 5	50 animals and birds.

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[1] Applicants for license under 16 years old must furnish written consent of parents or guardians.

[2] Members of incorporated game clubs owning real estate assessed at not less than $1,000 and organized prior to 1907, owners of real estate assessed at not less than $500, or nonresidents invited (for not more than 4 days) by members of incorporated club for hunting foxes, pay a fee of $1.

[3] United States soldiers stationed in the State and officers of the United States Forest Service classed as residents.

[4] Licenses not issued to boys under 18 without written permission of parent or guardian.

[5] Issued in the following 58 counties: Beaufort, Bertie, Cabarrus, Camden, Carteret, Caswell, Catawba, Chowan, Clay, Cleveland, Currituck, Dare, Davie, Duplin, Forsyth, Franklin, Gaston, Gates, Graham, Halifax, Harnett, Henderson, Hertford, Hyde, Jackson, Johnston, Jones, Lincoln, Macon, Madison, Martin, Mitchell, Montgomery, Nash, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Pitt, Polk, Randolph, Richmond, Robeson, Sampson, Stanly, Stokes, Swain, Transylvania, Tyrrell, Union, Vance, Warren, Washington, Wayne, Wilkes, Wilson, Yadkin. Special license provisions are in force in Alexander (also quail export limit), Caswell, Clay, Craven, Dare (wildfowl), Gaston, Granville, Haywood, Hyde, Jackson, Lincoln, Northampton, Pamlico, and Warren counties. Details of these are given in Poster No. 26, copies of which may be had free on application to the Biological Survey, U. S. Department of Agriculture.

[6] Not required of owner or occupant of agricultural lands or members of his immediate family hunting on such lands.

Details of hunting licenses and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Export limit.
Oklahoma	Nonresident	$15.00	Warden or county clerk	Expires May 1	2 days' bag limit.
	Alien	25.00	do	do	
	Resident citizen	1.25	do	Not required of minor under 14 years, or person hunting on his own or leased lands.	
Oregon	Nonresident	10.00	County clerk	Not required of landowners hunting on their own premises. Good for 1 year.	No export allowed, except by Washington hunters, who may take 1 day's bag.
	Resident	1.00	do	do	
Pennsylvania	Nonresident	10.00	County treasurer	Good for year of issue. Aliens not permittedto hunt.	1 day's bag limit.
Rhode Island [1]	Nonresident [2]	10.15	City or town clerk	Expires Dec. 31	10 birds.
	Alien	15.15	do		
	Resident	1.15	do	Not required of owner or occupant of agricultural land (or immediate family) hunting on such land.	
South Carolina	Nonresident and alien.	10.25	County clerk	All game except quail and turkeys. Good for season.	2 deer, 4 wild turkeys, 12 ruffed grouse, 50 each of partridges (quail), beach birds, ducks, geese.
	do	25.00	do	County license for quail and turkeys. Not required of person hunting on land he owns or controls or guest of and accompanied by resident freeholder.	
	Market hunting	50.00	County treasurer	County license for residents hunting wild fowl on public lands and navigable waters. Expires Dec. 31.	
South Dakota	Nonresident	25.00	Warden or county treasurer.	Big game and game birds. Expires June 30	Birds lawfully in possession.
	do	15.00	do	Game birds only	
	Resident	5.00	County treasurer	County license. Big game. Issued in county in which hunting is to be done.	
	do	1.00	Warden or county treasurer.	Game birds. Not required of landowner hunting on his own land.	
Tennessee	Nonresident	10.25	State warden	Not required of landowner paying $100 taxes. Expires Dec. 31.	Nonresident: 50 ducks; 30 of all other birds in aggregate. Resident: No export.
	Resident	3.00	do	Required when hunting on lands with verbal permission of owner.	
	Market hunting	25.00	do	Annual license; $200 bond required	
Texas	Noncitizen	15.00	Commissioner	Expires Dec. 31	3 deer, 75 ducks, 1 day's bag limit of other birds.
	Resident	1.75	County clerk	Not required in county of residence or adjoining counties or on land controlled by hunter. Expires Sept. 1.	
Utah	Nonresident	5.00	Commissioner or justice of peace.	Hunting and fishing. Expires Dec. 31	Nonresident: 1 day's bag limit. Resident: No export.
	Alien	100.00	do	do	
	Resident	1.25	do	Not required of females or children under 12	
Vermont	Nonresident [2]	10.50	Town clerk	Valid during open season	Nonresident: 1 deer; birds as stated on p. 42. Resident: 1 season's bag under license.
	Resident	.50	do	Not required of owners or tenants of farm lands (or their children) hunting on such lands.	

Virginia [4]	Nonresident [5]	10.00	County clerk	Good in open season in the 6 months following issue	1 deer, 50 quail, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, 25 of each or 100 in all, plover, snipe, sandpipers, willets, curlew, and tatlers.
Washington	Nonresident	10.00	State auditor	State license. Good for 1 year	Nonresident or nonresident alien: A season's limit of big game and a day's limit of birds. Resident: No export.
	....do	5.00	County auditor	County license	
	Alien, nonresident	50.00	State or county auditor	State or county license	
	Alien	15.00	State auditor	Gun license. Consular certificate required	
	Resident	5.00	....do	State license	
	....do	1.00	County auditor	County license	
West Virginia	Noncitizen	15.50	County clerk	County license. Good for 1 year; written consent of parent or guardian required if applicant is under 15.	No deer, quail, ruffed grouse, pheasants, wild turkeys.
Wisconsin [6]	Nonresident	25.00	Secretary of state	All game	Nonresident: 1 deer, 30 birds. Resident: No export.
	....do	10.00	....do	All game except deer	
	Resident [7]	1.00	County clerk		
Wyoming	Nonresident or alien	50.00	Justice of peace	Hunting and fishing. Each licensee must employ guide. Expires Dec. 31	2 elk, 2 deer, 1 sheep, 20 game birds.
	Nonresident	10.00	....do	Bear only	
	....do	5.00	....do	Hunting and fishing. Birds only	
	Alien	20.00	....do	....do	
	Resident [8]	2.50	Justice of peace or game warden	Ordinary	
	....do	5.00	....do	1 additional elk	
	....do	1.50	Justice of peace	Birds only. Licensee must be over 10 years old	
	Guide [9]	10.00	....do		

CANADA.

Alberta	Nonresident	25.00	Minister of agriculture	Expires Dec. 31	Nonresident: Under general license, trophies of big game legally killed. Resident: No export.
	....do	15.00	....do	Birds only. Expires Dec. 31	
	Guest	2.00	Game guardian	Guests of residents. Good for 5 days	
	Guide, camp help	5.00	Minister of agriculture	Resident maximum fee. Expires Dec. 31	
	Resident [10]	2.50	....do	Big game. Expires Dec. 31	
	Market hunting	10.00	....do	Expires Dec. 31	

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[1] Licensee must be at least 15 years of age.

[2] Nonresident citizens and members of hunting or fishing clubs incorporated prior to January 1, 1909, owning real estate to the value of $1,000, and nonresident citizens owning real estate assessed at not less than $500, pay a fee of $1.15.

[3] Not required of anyone owning improved real estate in Vermont, and paying taxes thereon on appraised value of $1,000.

[4] Rappahannock County requires written and duly acknowledged permission (good for 4 months) before permitting hunting or trapping on another's land.

[5] Guests not required to procure license to hunt on land of host, provided the host receives no compensation, directly or indirectly, from such guest and hunts with him.

[6] Bona fide settler who has not resided in the State 1 year may take out a special resident license.

[7] Owner or occupant of land or member of his family may hunt rabbits at any time and squirrels during open season on such land without license.

[8] Applicant must be an elector of the State; child or ward, over 14 years, of an elector; a soldier or sailor of the United States and an elector thereof, stationed 1 year at a post in the State; or a nonresident paying $100 or more taxes on property owned in the State. Soldier or sailor must employ guide.

[9] Guide must be citizen and qualified elector of State who is a free holder or has a valid filing on public lands in the State, must act as assistant game warden, and is equally responsible with employer for violation of law.

[10] Not required in northern Alberta.

Details of hunting licenses and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Export limit.
British Columbia	Nonresident	$100.00	Warden or any Government agent.	Members of Army, Navy, or Militia in actual service exempt.	Heads, hides, and horns of animals legally killed by licensees.
	do	50.00	do	Birds only. Good Sept. 1-Mar. 31	
	do	25.00	do	Bear. Good Jan. 1-July 15	
	do	5.00	do	Birds only. British subject. Good for 1 week	
Manitoba	do	50.00	Minister of agriculture	Expires Dec. 31	2 heads and skins each of game animals, 50 ducks, 100 geese or swans, other game birds, except partridge, grouse, and prarie chicken under permit.
	do	10.00	do	British subject	
	Resident	2.00	do	Big game only	
	do	1.00	do	Birds only. Required of resident of city or town	
New Brunswick	Nonresident	50.00	Surveyor general	Moose, caribou, and deer	No partridge; other game under permit.
	do	25.00	do	Special license for Westmorland county	
	do	10.00	do	2 l[illegible] Discretionary with surveyor general	
	do	10.00	do	Game birds	
	Resident	2.00	do	Moose, caribou, and deer	
	Sinkbox	1.00	do	For shooting geese and brant.	
	Guide	1.00	do	Resident accompanying anyone hunting big game	
	Camp help	1.00	do	Resident	
	do	50.00	do	Nonresident	
Newfoundland	Nonresident	51.00	Game and fisheries board	Good for season. Can not employ unlicensed guide	3 caribou under license and permit.
	Guide	50.00	do	Nonresident. Resident guide licenses free	
Nova Scotia	Nonresident	30.00	Provincial secretary, or game commissioners.	Expires Aug. 1. Must employ licensed guide	1 moose lawfully killed by licensee.
	do	15.00	do	Birds and small game, except woodcock and snipe	
	Resident	5.00	do	For woodcock and snipe outside county	
	Guide	2.00	do	Resident. Expires Aug. 1	
Ontario	Nonresident	50.00	Superintendent of game		1 deer, 1 bull moose, 1 bull caribou lawfully killed by licensee.
	Resident	5.00	do	Moose and caribou	
	do	2.00	do	Deer	
	Guest		do	No fee required. Good for 1 week or less	
	Nonresident	25.00	do	Ducks and other small game	100 ducks lawfully killed by licensee.
	Guide	2.00	do	Maximum fee	
Prince Edward Id	Nonresident	15.00	Game inspector	All game. Expires 1 year after date	12 birds (except geese and brant).
Quebec	Nonresident	25.00	Minister of colonization	All game	
	do	10.00	do	Issued to members of incorporated hunting clubs	
	Resident	1.00	do	Big game. Not required of person hunting for own use	
	do	5.00	do	3 deer and 3 caribou additional to bag limit	
Saskatchewan	Nonresident	50.00	Minister of agriculture	Big game only. Expires Dec. 31	Trophies of big game legally killed.
	do	25.00	do	Birds only. Expires Dec. 31	Limited amount under permit.
	do	10.00	do	Birds only. Good for 6 days	
	Resident	2.00	Minister or agent	Big game. Expires Dec. 31	
	do	1.00	do	Birds only. Required of resident of city or town	
Yukon	Nonresident	100.00	Commissioner	Big game only	Bag limit under permit to 1912.

Issued December 19, 1911.

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FARMERS' BULLETIN 471.

GRAPE PROPAGATION, PRUNING, AND TRAINING.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 18, 1911.

Sir: I have the honor to transmit herewith a paper entitled "Grape Propagation, Pruning, and Training," by Mr. George C. Husmann, Pomologist in Charge of Viticultural Investigations of this Bureau.

The number of requests received for such general instructions as this article gives is large and constantly increasing, and it is thought that the publication of this paper as a Farmers' Bulletin will best enable the Department of Agriculture to supply the popular demand for such information. Its publication is therefore recommended.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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GRAPE PROPAGATION, PRUNING, AND TRAINING.

INTRODUCTION.

By nature the grapevine is a great rambler. Forms of it are found in our woods striving to overtop the tallest trees, and single plants overspread large areas. Again, other forms are grown as mere bushes, 2 or 3 feet high, producing crops ranging from 1½ to 22 tons of fruit to the acre. No other fruit-bearing plant responds so generously to attention, adjusts itself to so many conditions, or is used for such a variety of purposes. For these reasons its culture has always kept pace with civilization. Grapes are often grown on soils too poor for other purposes.

FIG. 1.—An experiment vineyard of the Bureau of Plant Industry.

Native species of the grape are found in nearly all parts of the world, and no country is blessed with a greater number of them than our own. It is therefore reasonable to conclude that grapes can be successfully grown almost everywhere in this country, results with them depending largely upon the selection of varieties of the species suited to the respective conditions. (Fig. 1.)

PROPAGATION OF THE GRAPE.

SEEDLINGS.

In ordinary practice grapevines are propagated from seed, from cuttings, by layering, or by grafting. For originating new varieties, seedlings must of course be used. The individual seedlings differ so widely that they are seldom used by the intelligent planter even for grafting stock.

CUTTINGS.

Cuttings for propagation may be prepared at any time after the vines have become dormant. Other things being equal, and if they are afterwards well cared for, the sooner they are prepared after the vines have become dormant the better. The length of the cuttings may vary from 8 to 20 inches, depending on the climatic and other conditions of the locality in which they are to be planted. Usually, the hotter and drier the climate the longer the cuttings will need to be. They should always be made from young, well-matured wood, and preferably from medium-sized, short-jointed wood.

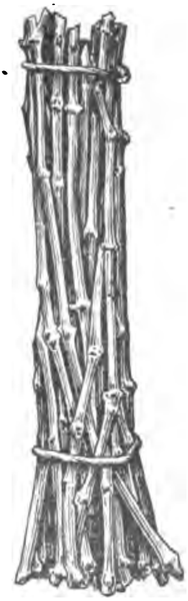

FIG. 2.—A bundle of grape cuttings.

To make cuttings, cut close below the lower bud, making the cut somewhat slanting (fig. 2), and leave about an inch of wood above the upper bud or eye. If a small piece of the old wood or a whorl of buds can be left to form the butt end of the cutting, so much the better. The cuttings should be tied in convenient-sized bundles, the butts being turned the same way. The bundles should then be heeled in or buried in trenches, butt ends up, and well covered with 3 to 6 inches of soil. (Fig. 6.) Inverting the bundles causes the butts to callus while the tops remain dormant, and the cuttings are ready to throw out rootlets as soon as planted; whereas, if the bundles are heeled in with the tops up the latter often start to grow before the roots to support them do.

In the spring, when the ground has become warm enough, plant the cuttings in soil made mellow by plowing and cultivating. The planting may be done in slanting trenches, 3 or 4 feet apart, which can be made with a plow. Deepen the trenches with a spade if necessary. Set the cuttings at such depth that only the upper buds will project above the ground and firm the soil well around them. The cuttings should be spaced 2 to 3 inches apart, the distance between them differing with the varieties, some rooting more readily than others. Keep the soil clean with hoe and cultivator, and stir often during the summer to keep it mellow and moist. Frequent stirring in many localities is better than irrigation.

LAYERS.

All varieties of the vine may be propagated by layers. The Rotundifolia vines are nearly always propagated in this manner, but with other species layering is usually resorted to only with varieties which do not root readily from cuttings. In layering choose canes of the last season's growth, preferably those that start near the base of the vine. (Fig. 3.)

It is well, the summer before, to leave on the vine for this purpose some shoots starting close above ground and allow them to grow as long as possible. In pruning these canes all the well-developed buds are left. The ground is made mellow, a trench about 2 inches deep is drawn from the vine with the hoe, and the cane is bent down and fastened in it. Each bud on the cane will usually produce a shoot, which by this process is made to grow upward. When these shoots are well started the trench should be filled with soil. Each of the shoots then takes root at its base. To assist the roots in starting, a slight incision should be made in the cane opposite each shoot. The plants are taken up in the fall or winter, being divided by severing the original cane behind each shoot, which, having its own system of roots, becomes a new vine. (Fig. 3.) Canes may be layered either in the fall or in the spring.

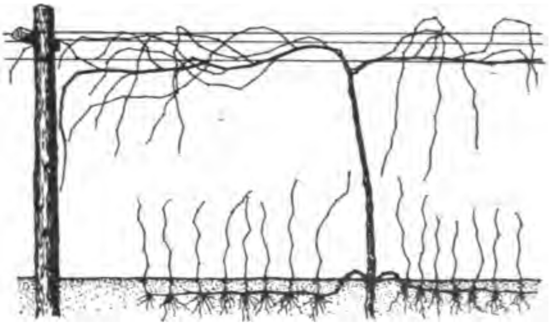

FIG. 3.—A vine with two canes layered, showing the method of propagation by layers.

GRAFTING.

There are many so-called methods of grafting. The following descriptions include only those most generally used. Bench, nursery, and vineyard grafting are resorted to in general vineyard practice. The mechanical operations performed are similar and the underlying principles are the same, the essential difference being, as the names imply, the place where the work is done.

Bench grafting is done on benches or tables, usually indoors during winter. Cuttings of resistant varieties that root easily or good, young, rooted plants are usually bench grafted.

The grafting of vines growing in the nursery is called nursery grafting. This form of propagation is usually resorted to with varieties resistant to phylloxera that do not grow readily from cuttings. Rooted cuttings of other varieties are grafted in the nursery and the resulting vines planted in the vineyard.

In vineyard grafting the vines growing where they are to remain are grafted.

Some of the important practical advantages of grafting are: (1) Changing worthless vines into valuable ones; (2) insuring non-resistant varieties against phylloxera by grafting them on resistant stocks; (3) obtaining quickly plenty of wood for propagating purposes by grafting new or scarce varieties on strong vines; and (4) producing resistant vineyards by grafting valuable resistants or direct producers on roots of growing vines and then allowing the scions to make roots of their own.

The selection and proper keeping of the scions for grafting are very important. Medium-sized, short-jointed, firm, well-ripened wood should be selected. Do not allow the scions to dry out, but keep them dormant until used by covering completely with fairly dry sand in a cool, dry cellar.

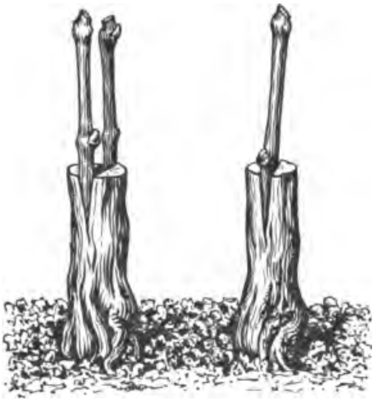

FIG. 4.—Vines grafted according to the cleft-graft method: At the left with two scions; at the right with one scion.

In all grafting a joining of the inner bark of the stock and scion must be accomplished. This bark is thicker on large than on small stocks; hence it is usually thicker on the stock than on the scion. The union, especially in vineyard grafting, needs to be closely observed when the scions are inserted. In bench grafting, scions and stocks of like diameter can be selected, making possible such perfect grafting that the inner barks join at almost every point, allowing their knitting to become easy and complete. (Fig. 5.)

In bench grafting, the visible and adventitious buds are cut out of the cuttings used as stocks so as to prevent as much as possible the sprouting of suckers from the stocks after they are planted.

In vineyard grafting, many operators, a month or so before grafting, cut off the stem of the vine an inch or two above where it is to be grafted so that the stock may bleed profusely. Water sprouts that otherwise would appear are thus to a great extent eliminated.

In cleft grafting, the vines are cut off at a smooth place near and preferably a little above the surface of the ground, unless it is desired to have the grafts establish themselves on their own roots, as it makes the removal of water sprouts and roots starting from the scion much easier and lessens the danger of injuring the scion before it is thoroughly knitted to the stock. (Fig. 4.)

In bench grafting, a smooth surface for grafting is selected above a node on the stock. The node keeps the stock from splitting below it during the grafting process. After cutting off the stock, whether a vine or a cutting, split it longitudinally with a sharp knife or shears, or if a heavy vine with a chisel. In cleft-grafting stocks not more than an inch in diameter the shears can be used in making both the horizontal and the longitudinal cuts. (Fig. 4.) To prevent the bruising of the bark in cutting, keep the blade of the shears on the side where the scion is to be inserted. To prepare the scion, cut with a sharp knife a simple wedge, beginning at or slightly below a bud and making a long sloping cut toward the middle and a similar one on the opposite side. Scions of two eyes are preferable. To insert, open the cleft and push the scion in firmly until the bud is just above the upper end of the stock, taking care that the inner barks of stock and scion fit closely. When large vines are grafted it may require a metal wedge to open the cleft. In large vines two scions, one on each side, are frequently used.

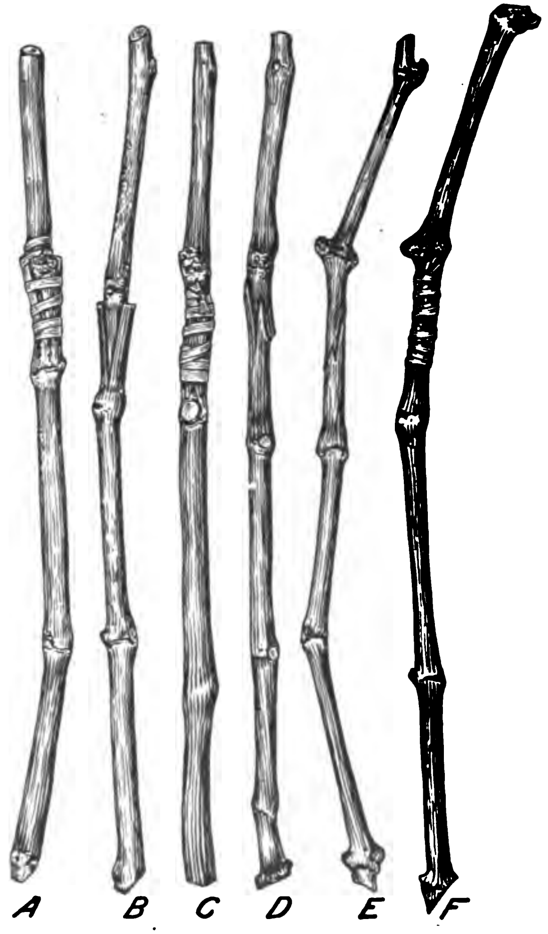

FIG. 5.—Bench-grafted cuttings of grapevines, showing three methods of grafting: *A, C, F,* Grafts tied with raffia; *B,* bench cleft graft; *D,* bench whip graft; *E,* English cleft, split, or whip graft.

Another favorite method with small stocks, especially in bench grafting when the diameter of the stock is the same or very little greater than that of the scion, is the English cleft, split, or whip graft. (Fig. 5, *E.*) By this method a sloping transverse cut is made upward on the stock and a split downward from the middle of the cut. In the scion just the reverse but a like split and cut are made. Then the upper wedge made in the scion is pushed into the split of the stock in such a way that the inner barks join and fit closely.

When grafting is done near the ground on stocks strong enough to hold the scions firmly no tying is necessary; otherwise they should be tied with raffia, as shown in figure 5, *A*, *C*, and *F*. In either case a stake should be driven at the side of the graft to protect it and to provide a support for the young shoots. It is good practice to press a little moist soil over the cut around the junction of the graft and to cover the scion completely with fine dirt, hilling it up sufficiently to protect it from drying out.

When vines grafted above ground are not covered with dirt the entire cuts should be waxed to exclude the air. The grafts should be examined frequently and the suckers removed, and the roots starting from scions that have been grafted on resistant stocks should be cut off.

Bench grafts are also tied with raffia. (Fig. 5.) They may be planted out directly, but bench-grafted cuttings are usually stored or are heeled in upside down in damp, not wet, river sand, moss, or other suitable material, to allow them to callus before planting. (Fig. 6.)

SOIL AND LOCATION.

The soil and location best suited, the preparation of the soil, the laying out of and cost per acre of establishing a vineyard, and the cultivation and fertilization necessary for obtaining the best results are not presented here, as they vary decidedly with differing conditions of soil, climate, etc., and need to be dealt with in a special treatise on the subject.

The uses and manipulation of the vine for various purposes and the insect and fungous enemies of the grape, with methods of combating them, are discussed in other publications.[1]

DESCRIPTION OF THE PARTS OF A VINE.

A clear understanding of the names of the different parts of a vine is necessary before the subject of grape training is considered.

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[1] Farmers' Bulletins: No. 27, Important Insecticides; Directions for Their Preparation and Use. No. 175, Home Manufacture and Use of Unfermented Grape Juice. No. 243, Fungicides and Their Use in Preventing Diseases of Fruits. No. 284, Insect and Fungous Enemies of the Grape East of the Rocky Mountains. Yearbook Papers: No. 281, Grape, Raisin, and Wine Production in the United States. No. 354, Some Uses of the Grapevine and Its Fruit. These publications are issued for free distribution and may be obtained upon application to the Secretary of Agriculture or any Member of Congress

Figure 7 illustrates a vine, the different parts of which are shown by letters, as follows: *T*, trunk, the stem or main body of the vine; *B*, branches, which are of mature wood, being several years old; *A*, arms or ramifications of the branches, usually of wood two or more years old; *C*, canes, called shoots when green and canes when mature; *S*, suckers, the shoots which start below the ground from the main body; *WS*, water sprouts, the shoots which start above the ground from wood older than one year; *L*, laterals, the secondary shoots of a cane.

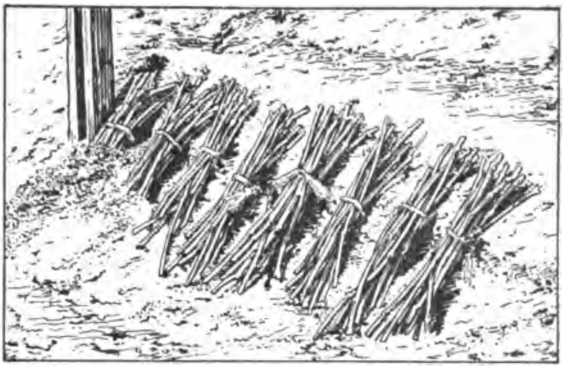

FIG. 6.—Grafts or cuttings ready for heeling in.

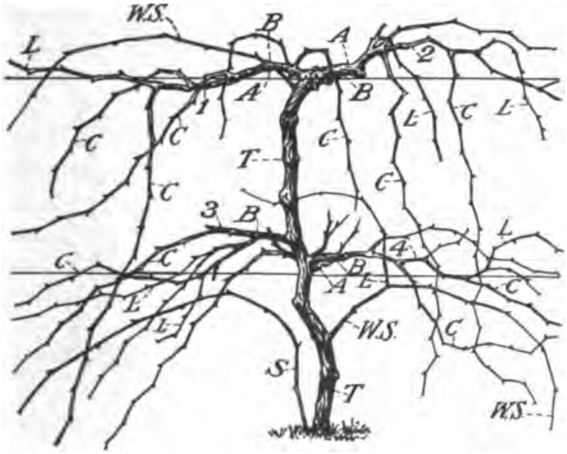

FIG. 7.—Diagram of a grapevine, showing the different parts and illustrating the four-cane system of training: *A*, Arms or ramifications of the branches, usually of wood two or more years old; *B*, branches which are of mature wood, being several years old; *C*, canes, called shoots when green and canes when mature; *L*, laterals, the secondary shoots of a cane; *S*, suckers, the shoots starting below the ground from the main body; *T*, trunk, the stem or main body of the vine; *W. S.*, water sprouts, the shoots which start above the ground from wood older than one year; *1, 2, 3, 4*, 2-year old arms.

The basal eye or bud, which is not reckoned in counting the eyes on a spur, is near the base of the cane. When more than four eyes of a cane are left in pruning it is generally called a fruiting cane.

Water sprouts and suckers do not ordinarily produce bearing shoots.

Below the basal bud on each cane are one or more dormant buds, which grow and produce sterile canes only when too few eyes are left in pruning or when the eyes have been destroyed. At the base of each eye on a cane there are two dormant buds. Sometimes one of these grows the season it is formed, making a lateral from which secondary laterals also may grow.

The first and secondary laterals bear the so-called second and third crops of grapes.

CARE AND TRAINING OF YOUNG VINES.

The treatment given vines during the first years of their growth largely determines the profit and pleasure to be derived from them. If improperly cared for during this period satisfactory returns are not obtained afterwards.

PLANTING CUTTINGS OR ROOTED VINES.

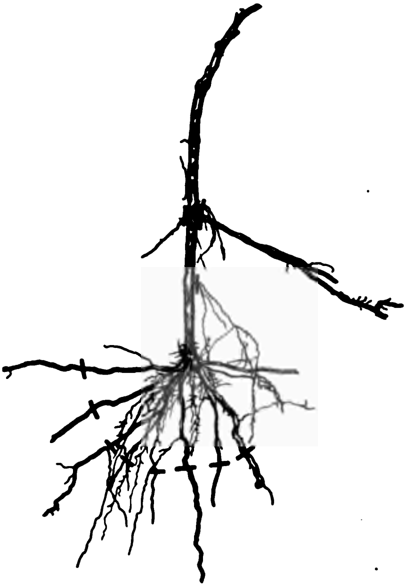

FIG. 8.—A grapevine showing the method of pruning roots ready for planting.

If cuttings (fig. 2) are planted and the supply is sufficient, two in each place increases the chances of getting a full stand. Should both cuttings grow, one of them can easily be pulled up without injuring the other. To protect the cuttings from drying out, plant them so that the top bud projects only a trifle above the ground.

If rooted vines, either plain or grafted, are used, the roots should be cut back to 3 to 4 inches, depending on their vigor. Only one cane of the top should be left, and this should be cut back to two or three good buds. (Fig. 8.) If grafts are used, all scion roots and all suckers should be carefully removed.

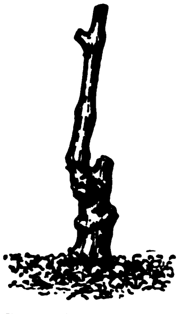

FIG. 9.—A vine pruned at the end of the first year.

During the first year after planting, no pruning or training is usually given, although it is, perhaps, a good plan with vigorous plants, especially if the season is propitious, to rub off all except the straightest and strongest of the young shoots that start. (Fig. 9.) The following winter the vines should be pruned and staked before they start to grow, the size of the stake used depending on the method of training adopted. In ordinary stool or spur pruning, or where the vines are to be trellised or arbored afterwards, a stake 1½ to 2 inches square should be used, long enough so that after being driven 1½ feet into the ground it will reach 1 or 2 inches above where the vine tied to it is to be headed. If the vines are to be pruned to canes and the latter tied to stakes, it will be necessary to use stakes 2 inches square and 5 to 6 feet long. (Fig. 11.) When Rotundifolia varieties are to be grown on overhead arbors, posts projecting about 7 feet above the ground should be planted on the side of each vine opposite the prevailing wind. (Figs. 10 and 11.)

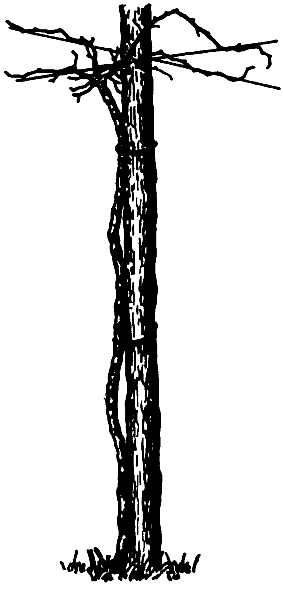

FIG. 10.—A Rotundifolia grapevine trained to a post.

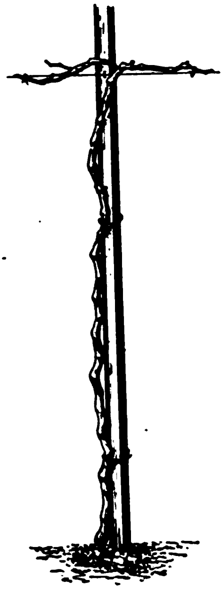

FIG. 11. — A grapevine trained to a stake.

FIRST PRUNING AFTER PLANTING.

The first pruning after planting may be done at any time during the winter when the vines are dormant and not frozen. The extent of the pruning will depend on the growth made. If the growth has been small, all the canes except the strongest should be removed, and this one cut back to two eyes. (Fig. 9.) If a strong growth has been made and there is one straight well-ripened cane, all other growth should be removed and this cane cut back to the height at which it is intended to head the vine. The cane should be tied securely and, as it is to become and remain the trunk or main body of the vine, should be kept as nearly erect and straight as possible. (Fig. 12.)

SUMMER PRUNING.

Where the vine was cut back to two buds only one should be allowed to grow. All other young shoots should be removed (fig. 12), preferably when quite young and not more than 3 or 4 inches long. This concentrates all the force and growth of the plant into the cane, which is to become the trunk of the vine. The shoot left to grow must be kept carefully tied to the stake to cause it to grow erect and also to protect it from being broken by the wind or other agency. When a shoot has grown to a foot above where it is intended to head it should be topped slightly above where the head is to be, causing laterals to grow where they are desired. Only such shoots should be allowed to grow as are needed for shaping the vine for the following season. (Fig. 13.) All suckers should be promptly removed.

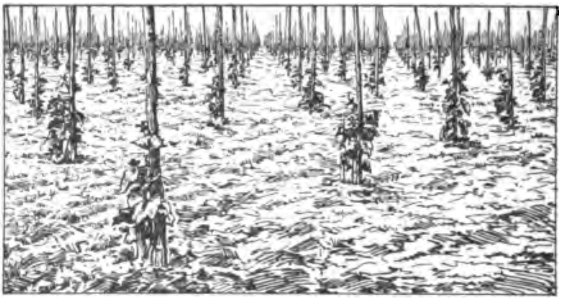

FIG. 12.—Vines growing in a vineyard the first year, showing single shoots tied to stakes.

WINTER PRUNING.

By the third year all vines should have erect, straight stems with two or more canes growing from the principal part, out of which the head or crown is to be formed and from which the growth of the vine is to be renewed from year to year. (Fig. 13.)

The vine, when permitted to do so, bears its fruit on shoots from the last year's wood growth; therefore, the cardinal point underlying all correct pruning, be the method of training what it may, is first to grow and shape or adjust the main body or permanent part of the vine to the method of training desired. After this has been done the growth on this, the fruit-bearing part of the plant, should be so pruned that it will be renewed from year to year, never allowing the

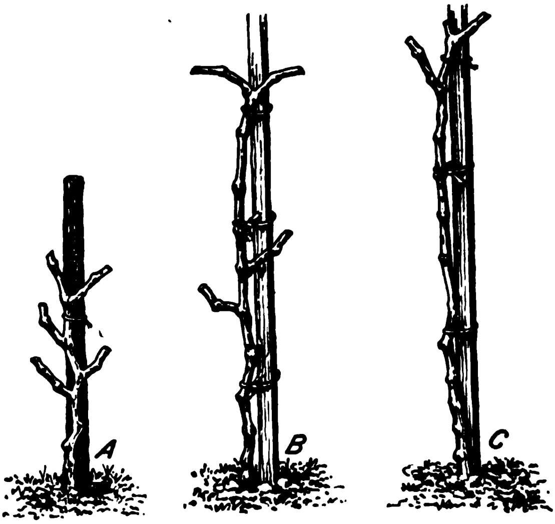

FIG. 13.—Vines headed back for different systems of training: *A*, The spur and fan systems; *B*, the four-arm renewal system; *C* the two-arm Kniffin, Munson, umbrella, and overhead systems.

plant to overbear but making it bear to its full capacity. If this is done the body of the plant gradually becomes stronger and its fruiting capacity increases correspondingly, no wasteful plant growth is allowed at the expense of fruitage, and the vines are easily kept clear of insects and fungous diseases. The manner of renewing the growth on the body of the vine so as to leave the body permanent is illustrated in figures 7 and 14, which show the same vine before and after pruning.

In figure 7 the 2-year-old arms *1*, *2*, *3*, and *4*, which grew during the previous summer, were the only ones allowed to remain of all the canes when the vine was pruned in the winter. The canes shown grew from these and bore fruit the next summer. When pruned the following winter, as seen in figure 14, only the canes *a*, *b*, *c*, and *d* were left, and these were tied to the wire in the same manner as the arms *1*, *2*, *3*, and *4* of the season before. (Fig. 7.) The spurs shown (fig. 14, *Sp.*) are canes cut back to one to four eyes for the purpose of starting new canes to be left the following year. It took 10 cuts to prune the entire vine.

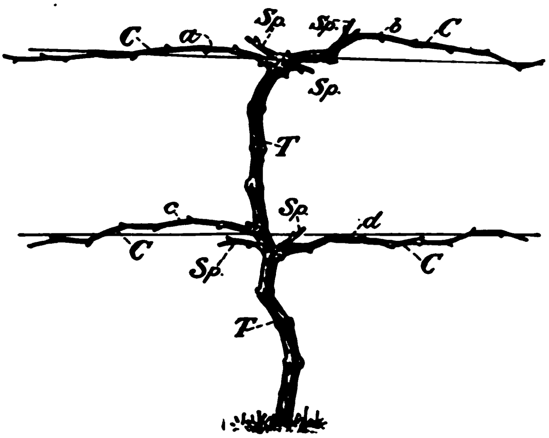

FIG. 14.—A vine pruned according to the four-cane Kniffin system: *C*, Canes, called shoots when green and canes when mature; *Sp*, spurs, canes cut back to one to four eyes; *T*, trunk, the stem or main body of the vine; *a*, *b*, *c*, *d*, arms succeeding those shown at their 2-year old stage in figure 7 at *1*, *2*, *3*, *4*.

Not only do different countries have different methods of pruning and training, but methods often vary in the several districts of the same country. The inherent peculiarities of the varieties themselves often require special methods to obtain the best results. No attempt will be made to describe methods other than those that appear most applicable and have proved most satisfactory for the grape species grown in various parts of the United States.

THE PRUNING OF BEARING VINES.

PRINCIPLES CONSIDERED IN PRUNING.

To prune intelligently, the age, size, and condition of the plant, the location, climate, soil, and other features of its environment, and the principles governing its life must be considered.

A statement of some of the more important of these life principles follows: The sap flows with greatest force to the outer extremities; the more upright a branch is, the more sap flows into it; the sap when abundant and active produces wood; the more abundant the flow of the sap, the larger and later the fruit; the ascending sap grows richer the farther it flows; checking the flow of the sap makes the plant bear earlier and produces more and richer fruit. The vine usually bears its fruit on new shoots growing from the wood of the previous year. The time for pruning is in winter, when the vines are dormant. They should not be cut when frozen or while the sap is flowing rapidly. Summer pruning is practiced on the young growth to regulate the quantity of fruit and the shape of the plant.

OBJECTS OF PRUNING.

In pruning, one or more of the following objects are usually accomplished: Parts of plants removed, renewed, promoted, or retarded; wounded and diseased plants cured; the shapes and habits of plants modified; the size and quantity of the fruit increased or diminished; the quality of the fruit improved; the fruit made to ripen earlier or later; a regular succession of fruit secured; and the spraying, training, cultivation, and gathering of the fruit facilitated.

METHODS USED IN PRUNING.

There are various ways in which the objects of pruning are accomplished. For instance, the growth and health of a plant are promoted and the size of the fruit is increased (1) by removing all the diseased parts and suckers; (2) by shortening extended shoots, side shoots, and laterals; (3) by putting upright the part whose rapid growth is desired; and (4) by removing the fruit buds or fruit. The plant is retarded in growth and made to bear earlier and richer fruit by shortening the leading shoots and leaving the fruit-bearing wood and by bending down the branches and ring-pruning them. The healing of wounded and diseased plants is promoted by removing the injured parts and dressing the wound. The head of a plant is renewed by cutting off the branches above; the head is made to grow thicker by cutting back the outer branches and to grow thinner by amputating all canes on which there is too much growth.

There are so many species of grapes, each having peculiarities of its own and therefore responding most readily to certain cultural methods to which it is best adapted, that the pruning, training, and growing of vines, which otherwise may appear quite simple, become complicated operations in which comparatively few people become expert, and vineyards in which serious mistakes are not made are rare.

TRAINING AND TRAINING SYSTEMS.

Around city homes where there is room for only a few vines, they are often trained on porches, fences, outbuildings, trees, etc. Where there is sufficient space an arbor like that shown in figure 15 is a good and attractive support, making the vine furnish a shady bower or walk as well as fruit. In vineyard practice some growers use only a stake or post on which to train each vine. (Fig. 11.)

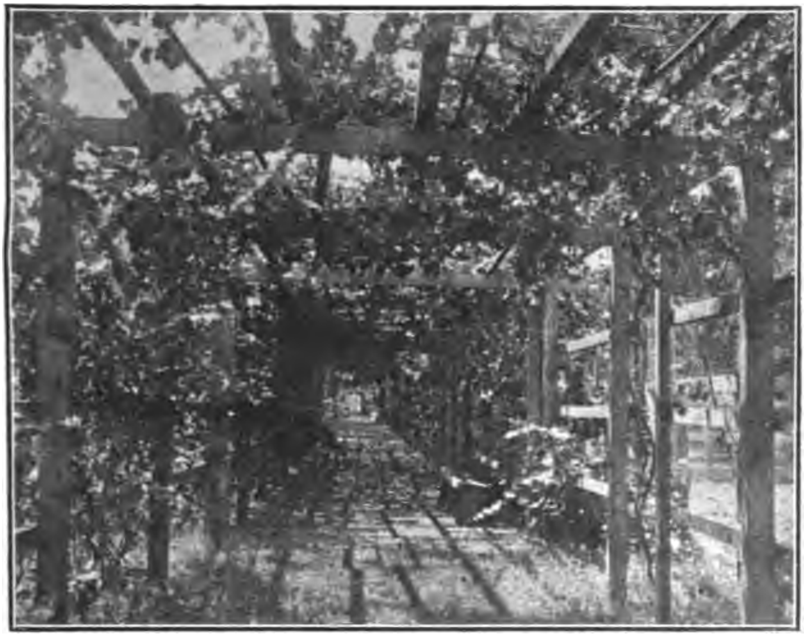

FIG. 15.—A grape arbor.

THE TRELLIS.

A support very generally used on which to train the vine consists of substantial posts of durable timber planted at regular intervals, the distance apart varying with the different grape varieties and the distances between the plants. (Fig. 16.) To the posts sometimes only two, but generally three, strands of No. 10 or No. 12 wire are fastened, the first, second, and third wires being 24, 40, and 56 inches, respectively, from the ground. The end posts of the rows should be firmly braced. The two most common methods of bracing

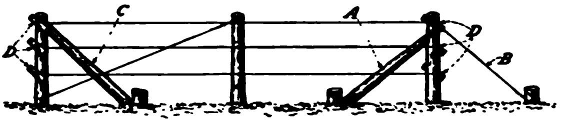

FIG. 16.—Diagram of an ordinary trellis, showing the braces (*A*, *B*, *C*) and devices (*D*) used for tightening the wires.

are shown in figure 16, *A* and *B*. Another post-bracing method often used is shown at *C* in figure 16. As wire contracts in cold and expands in warm weather, the trellis wire should not be stapled to the end posts but should be fastened to them by some device like a simple reel, as shown at *D* in figure 16. Some use a clamp pulley and a rope for tightening the wire and then wind the slack part two or three times around the end post to fasten it.

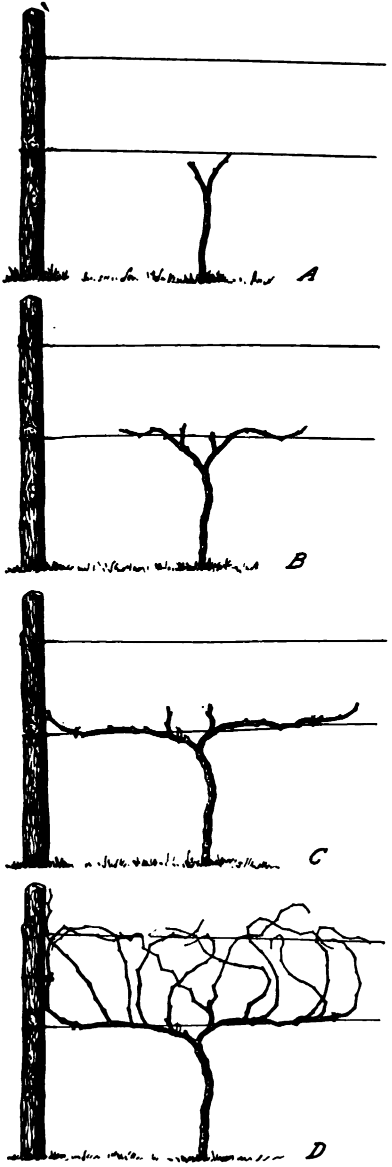

FIG. 17.—A pruned and an unpruned vine at different ages, showing the method of pruning by the renewal system: *A*, Second year; *B*, third year; *C*, fourth year; *D*, an unpruned vine in its fourth year.

THE HIGH-RENEWAL OR UPRIGHT SYSTEM.

In the high-renewal or upright system of training, all the season's growth is cut off each year except the head of the vine, which is cut back, leaving a cane and a spur on each side, and the canes are tied to the lower wire on the trellis. The length of the canes and the number of the eyes left on them will vary with the variety and size of the vine. The fruiting shoots growing from the canes are trained upright and fastened to the wire overhead. Figure 17, *A*, shows a vine pruned according to this system at the end of the second and figure 17, *B*, at the end of the third year. Figure 17, *D* and *C*, shows the same vine a year later, before and after pruning. This system is the one most generally practiced in the training of American grape varieties. Vines trained by this system can be easily laid down and covered in winter in the extreme northern sections.

A small amount of wood is left in pruning healthy vines and a good quality of fruit is obtained.

THE HORIZONTAL-ARM SPUR SYSTEM.

In the horizontal-arm spur system two horizontal arms, one on each side, are grown from the body of the vine at the lower wire of the trellis and tied to this wire. These arms remain, but the canes on them are cut back every year to spurs of two fruitful buds each. The fruit-bearing shoots growing from these are tied to the wires overhead, the number of spurs left depending on the variety and size of the vine. New spurs to replace those becoming weak or out of shape are grown from new shoots starting from the horizontal arm.

In this system the vines are pruned and trained the same as for the high-renewal system, up to the end of the fourth year. Sometimes the horizontal arms are also renewed. Figure 17, *D*, represents an unpruned vine. Figure 18 represents the same vine pruned according to this system.

This system was at one time extensively practiced in the Chautauqua grape belt on Lake Erie. With it more fruit is obtained from some varieties than by the preceding method, which results in too much wood growth; otherwise it is not as good. More old wood is left and the pruning is more tedious and expensive than with the high-renewal system.

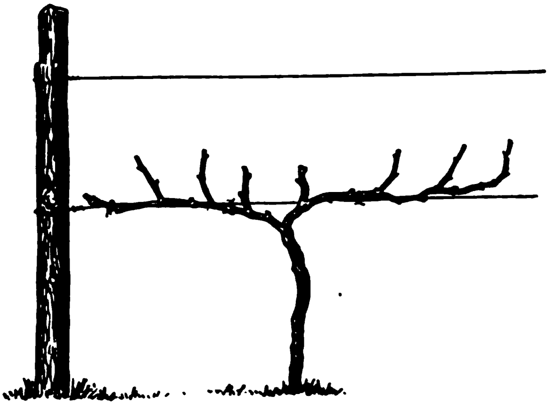

FIG. 18.—A vine in its fourth year pruned according to the horizontal-arm spur renewal system.

THE HORIZONTAL BLOCK SYSTEM.

A system combining some of the points of each of the preceding ones is the horizontal block system. In this the vines are manipulated as with the preceding systems and pruned in the same way for the first four years, after which the unpruned vine is pruned as shown in figure 19. As practiced in the same localities this system appears to be a combination of the high-renewal and the horizontal-arm spur systems.

THE FAN SYSTEM.

In the fan system the vine growth, which is trained to an upright trellis, is annually renewed to within a short distance from the ground. The vines are cut back usually to four canes and as many spurs each year; the canes are spread out and tied to the trellis, giving the vine the shape of a fan. Figure 20, *A* and *C*, shows an unpruned vine in the third and fourth years. Figure 20, *B*, shows the same vine pruned the fourth year for this system.

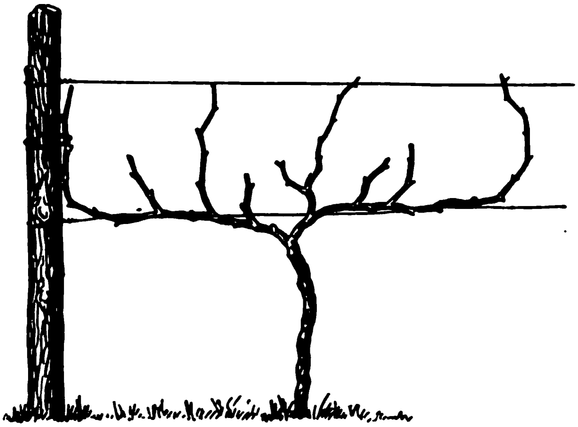

FIG. 19.—A vine in its fourth year pruned according to the block system.

The advantages claimed by the advocates of this system are (1) that most of the old wood is dispensed with each year, (2) that the vines can be easily laid down and covered in winter when needful in the extreme northern sections, and (3) that if after pruning the canes are tied and spread fan shaped on the trellis, as they should be, the young upright-growing shoots fasten themselves by their tendrils and need practically no tying. This system has the disadvantage of bearing the fruit too low and is not now so generally in use as formerly.

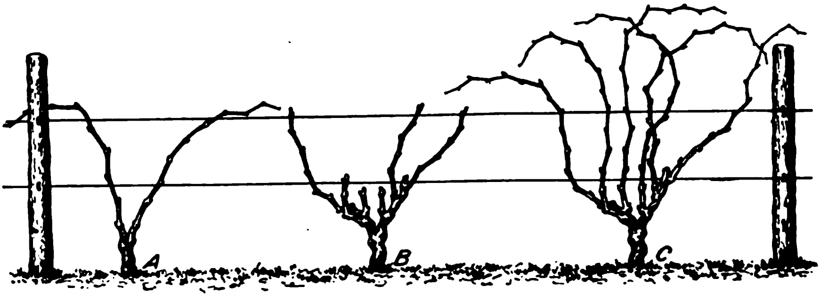

FIG. 20.—A vine at different ages, showing the method of training by the fan system: *A*, An unpruned vine in its third year; *B*, a pruned vine in its fourth year; *C*, an unpruned vine in its fourth year.

THE HUDSON HORIZONTAL SYSTEM.

The Hudson horizontal system, extensively practiced, as its name implies, along the Hudson River, uses an ordinary two-wire trellis. A strong stake reaching to the top wire of the trellis is driven behind each vine. Four perpendicular slats which do not touch the ground are fastened to the trellis, two on each side of the vine and 12 to 15 inches apart. Woven-wire fence could be substituted for the slats. The vine is annually renewed back to the trunk, which is about a foot high, and a single cane and spur are left at each pruning, the cane long enough so that when tied it reaches to the top of the stake. About six bearing shoots left to grow on each side of this cane are fastened horizontally to the slats. The clusters hang free from the shoots. When the shoots become too long they should be summer pruned. From the spur left on the trunk the cane is grown erect and tied to the stake, to become the fruiting cane to be left the next year. Figure 21, *A*, shows a vine at the end of the third year pruned according to this system. Figure 21, *C* and *B*, shows the same vine before and after pruning a year later.

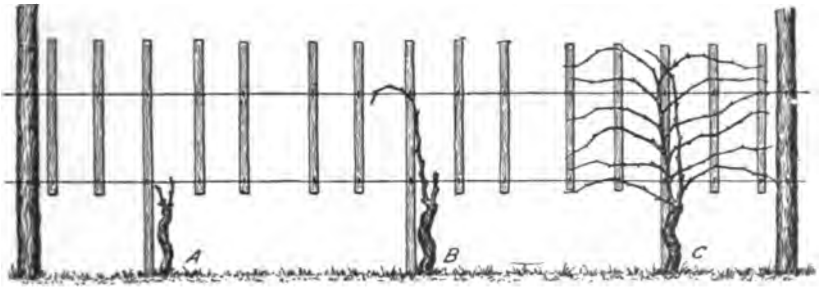

FIG. 21.—A vine at different ages, showing the method of training by the Hudson horizontal system: *A*, A pruned vine in its third year; *B*, a pruned vine in its fourth year; *C*, an unpruned vine in its fourth year.

The advocates of this system claim for it a more uniform distribution of the young shoots and say that the fruit hangs well supported and protected.

THE FOUR-CANE KNIFFIN SYSTEM.

On the trunk of the vine at the lower wire of a two-wire trellis, about 30 inches from the ground, two canes and two spurs are left of last year's growth, and two more canes and spurs are left at the top wire, about 56 inches from the ground. These canes, which are tied to the wire on each side of the vine, produce fruiting shoots which are allowed to hang down or droop as seen in figure 7. The same vine as it appears after pruning at the end of the fourth year when trained according to this four-cane Kniffin system is shown in figure 14. This system is named after William Kniffin, who first employed it. It has been extensively used along the Hudson River and elsewhere, and is said to be especially adapted to strong-growing varieties. Vines trained by this system are easily and quickly pruned and require only a limited amount of labor in the growing season.

THE UMBRELLA OR TWO-CANE KNIFFIN SYSTEM.

A system very generally used in the training of American vines, known as the umbrella or two-cane Kniffin system, differs from the foregoing in that no canes or spurs are left at the lower wire, the trunk of the vine extending directly to the top wire, where the growth is annually cut back to two canes and two spurs, one on each side, which are fastened to the top wire. It is best to tie the trunk to both the upper and lower wires to prevent violent whipping of the hanging shoots. Some growers dispense with the lower wire. Figure 22, *A* and *B*, shows a vine, trained according to this system, before and after pruning at the end of the fourth year.

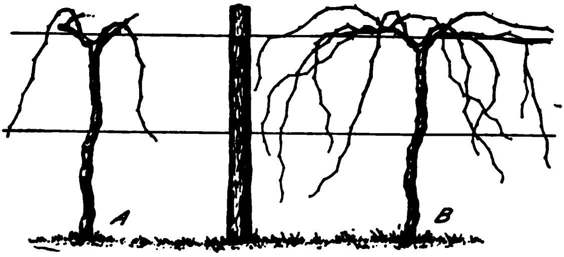

FIG. 22.—A pruned vine (*A*) and an unpruned vine (*B*), showing the method of training by the umbrella system.

This system is really an improvement on the four-cane Kniffin system. The absence of the two lower canes insures a good upright trunk, and the renewal of the fruit-bearing wood to one head makes the vine more easily pruned, leaves less old wood, and results in cleaner and better-ventilated vines.

THE MUNSON SYSTEM.

The Munson system derives its name from its originator, Prof. T. V. Munson, of Denison, Tex. As first practiced by him, use was made of two rows of light posts or stakes, the posts being driven opposite each other, their tops being about 18 to 20 inches apart. Wires were stretched along the tops of the posts in each row, with a third wire somewhat lower and midway between them upon cross wires.

Munson now uses single posts. Across the top of each post a crossbar of wood is fastened. The outer wires of the trellis are fastened to the outer ends of the crossbar, and the inner wire is fastened to the post the desired distance lower down. The writer secures essentially the same results in practice by using durable posts sufficiently heavy to allow pieces of 2 by 4 inch joist, 2 feet long, to be firmly spiked to them either at the side or on top, when sawed off at the right height for the purpose. The outer wires are stretched on the cross joist, and the lower wire is either stapled against or run through the posts at the desired distance below, as shown in figure 23, *B*. Four to 4½ feet above the ground is a good height for the lower wires for most varieties.

By this system a single main trunk for each vine is grown and tied to the lower wire. In pruning this trunk two canes and two spurs are annually left. The canes running to the right and to the left are securely tied to the lower wire. The outer wires are for the sole purpose of supporting the growing shoots, which naturally develop from the canes and gradually droop toward the ground. Figure 23, *A* and *B*, shows the vines pruned and unpruned, trained after the modified Munson system. The writer considers this the best all-round system of training for use in localities where rains and storms occur during the growing season. It protects the fruit and places it in the most advantageous surroundings for the best results. It makes practicable and facilitates spraying for fungous diseases and insect pests and, after the original outlay for the trellis has been incurred, lessens the cost of all operations and makes them easy and pleasant.

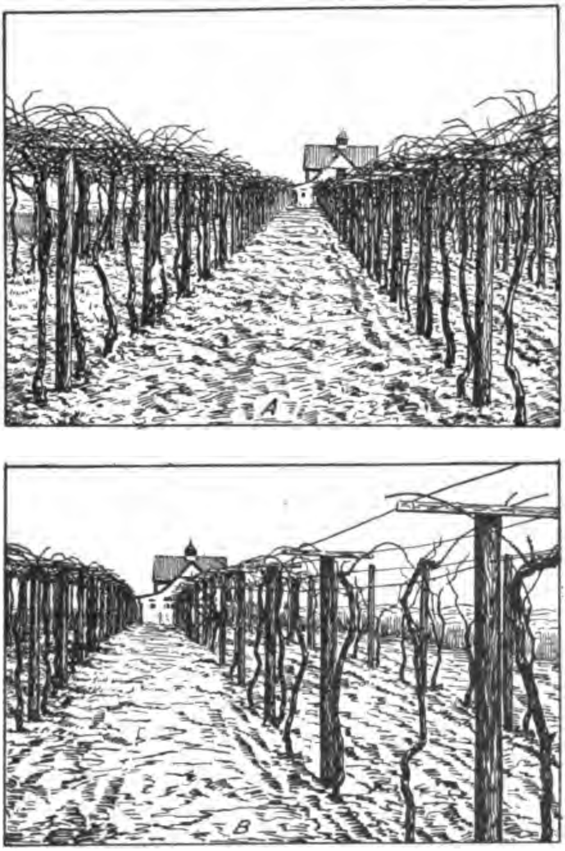

FIG. 23.—Unpruned vines (*A*) and pruned vines (*B*), showing the method of training by the modified Munson system.

THE OVERHEAD CAYWOOD SYSTEM.

In the overhead system, which has been used to some extent in New York, the vines are carried upon a canopy or overhead arbor 6 feet above the ground, consisting of three horizontal wires stretched at the same height. The center wire is fastened to posts which are placed at regular intervals, and the side wires are attached to 3-foot cross arms of wood fastened to the posts. The head of the vine is annually cut back to five canes and five spurs. The canes are fastened on the wires, two in one direction and three in the other, this division being alternated each year. Figure 24, *A* and *B*, shows vines pruned and unpruned, trained according to this system.

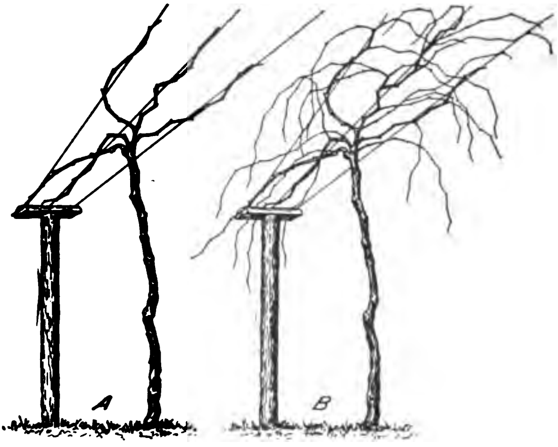

FIG. 24.—A pruned vine (*A*) and an unpruned vine (*B*), showing the method of training by the overhead Caywood system.

It has no advantages over the modified Munson system just described and to the writer appears inferior in every way.

THE CHITTENDEN SYSTEM.

The Chittenden system as employed in Michigan is similar to the overhead system, but the trellis is lower, not exceeding 4 or 5 feet.

THE MULTIPLE CROSS-WIRE SYSTEM, OR OVERHEAD ARBOR.

The multiple cross-wire system is used largely with the Rotundifolia varieties of the South, which are usually planted 10 by 20, 15 by 15, or 20 by 20 feet apart. In following this method a substantial, durable post reaching 7 feet above the ground is planted at each vine. Rows of well-braced posts, running parallel with and also at the ends of the rows of vines, are set at the boundaries of the vineyard. From the tops of these posts on the four sides of the vineyard a No. 10 galvanized wire is run along the tops of the inside posts down each row in both directions as a governor wire. No. 14 wires, 2 feet apart, are run parallel with the governor wires until in this manner the entire area has been regularly covered. It has been the general custom to cause a single trunk to grow erect from the ground up alongside each inside post, keeping it tied thereto. When the vine has reached the top of the post it is pinched in or cut back so as to make it throw out shoots to grow and spread over the arbor. When this object is accomplished it is the general practice to do no more pruning, the growers asserting that the vines prune themselves. There is no reason, however, why the Rotundifolia varieties should not be pruned and the fruit-bearing tops regularly renewed. Some growers construct arbors entirely of wood, using slats instead of wires. (Fig. 25.)

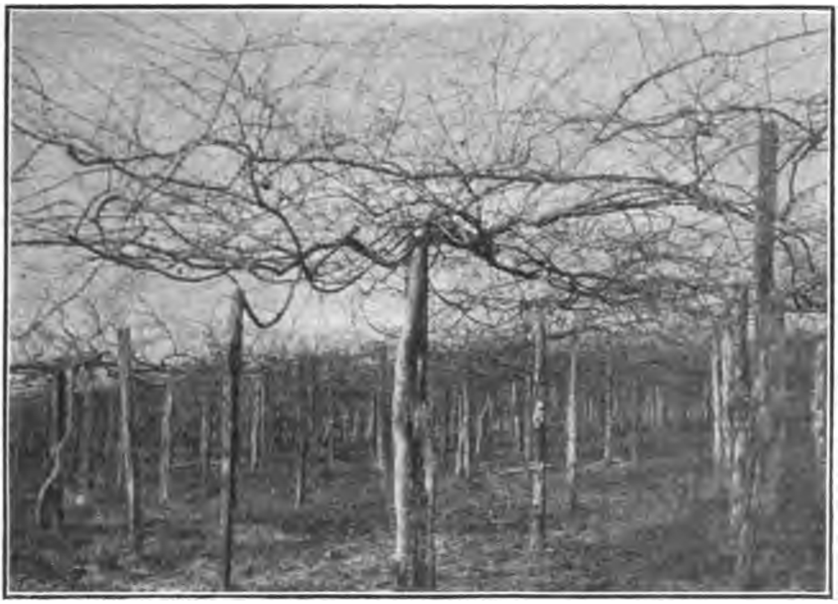

FIG. 25.—Vines trained by the multiple cross-wire system or overhead arbor.

From experiments as to the best methods of training Rotundifolia varieties, which the United States Department of Agriculture is conducting under the direction of the writer for the purpose of improving the quality of the fruit, getting better and more regular fruiting results, counteracting black-rot injury, etc., there is reason to believe it will soon be necessary to advocate the growing of Rotundifolia varieties on an upright trellis.

THE OVERHEAD TRELLIS OR PARRALES SYSTEM.

The overhead trellis or parrales system is used in Almeria in training the Ohanez and other Almerian varieties of grapes, large quantities of which shipped in cork dust reach our markets every year. The trellis used is practically the same as the overhead-wire trellis just described as in use for the Rotundifolia varieties. The Almerian vines are planted about 15 by 15 feet apart and trained with a straight stem to a height of about 7 feet. From the top of this stem fruiting canes varying from 10 to 15 in number and from 1 to 6 feet in length, according to the strength of the vine, are run out in all directions. These canes are annually renewed as near back to the main stem as possible with canes grown from spurs left for this purpose. (Fig. 26.)

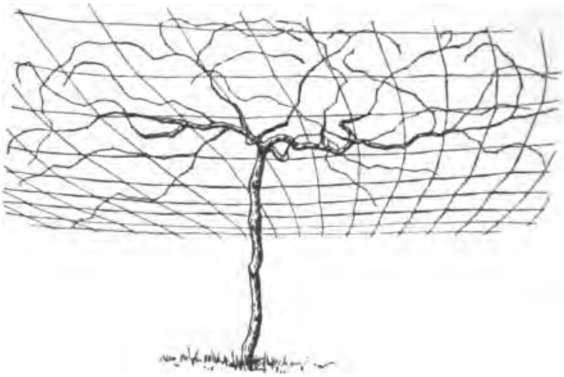

FIG. 26.—Parrales, showing the system of training and the arrangement of the wires.

THE CROSS-WIRE SYSTEM.

The single cross-wire system is used in the vicinity of Marlboro, N. Y. In this system posts are set 8 feet apart each way and made to project 6½ feet above the ground, a single wire running on top from post to post in both directions. A single trunk vine is trained up each post, four canes being run from it at the top of the post and one cane is fastened to each of the radiating wires. These canes are renewed each year. Figure 27 illustrates a vine pruned after this system.

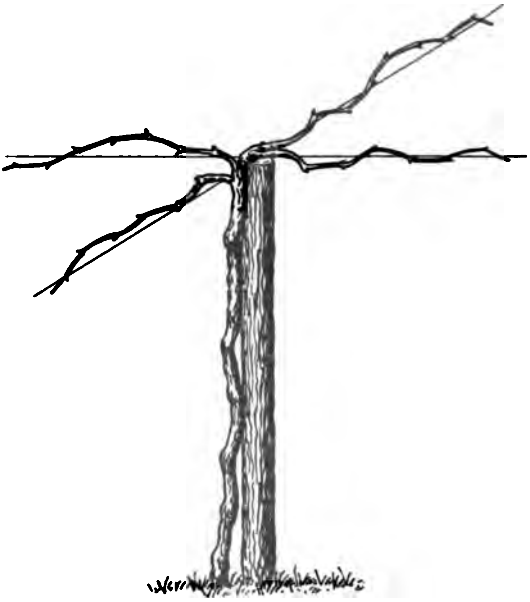

FIG. 27.—A pruned vine, showing the cross-wire system of training.

THE SPUR, STOOL, OR SHORT PRUNING SYSTEM.

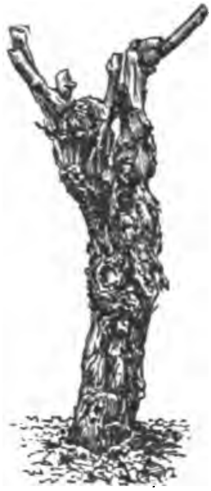

FIG. 28.—A pruned vine in its fifth year, showing the method of training by the spur, stool, or short system.

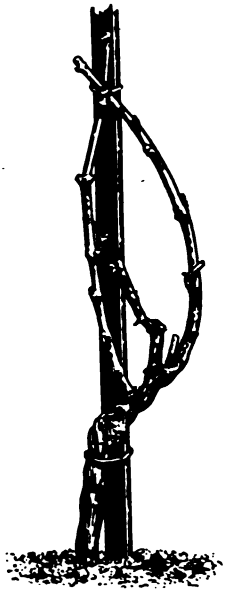

FIG. 29.—A pruned vine in its fifth year, showing the method of training by the cane system.

The spur, stool, or short pruning system is the one so extensively used in California with the stockier growing varieties of Vinifera. It is the simplest and cheapest method of pruning and training vines. By this method the body of the vine is grown to the desired height, and shoots are permitted to grow from only the two uppermost buds. The two resulting canes are cut back in the winter to spurs of two eyes each. The following year these spurs are allowed to produce growth and the resulting canes are again cut back to spurs and all of them allowed to remain if the vine is strong enough. (Fig. 13, A.) Thus the vine under ordinary conditions at the beginning of the fifth year consists of a trunk from which spring four or five arms, on each of which a cane has been cut back to a spur, as shown in figure 28. When the vine is pruned the following winter all or nearly all the outer canes that have grown from the spurs are entirely removed. The spurs of the last season are cut off just outside the inner canes, which are cut back to spurs, the pruning each winter after this being to promote a regular system of spur renewal. As the vines become older and stronger and can stand more cropping, more spurs are left to increase the fruiting capacity of the plant. In course of time the arms of the respective spurs are renewed and entirely new arms and spurs are grown. The head of the vine should be kept well balanced and given a globular form, if possible. Some varieties on which the lower eyes are not sufficiently productive may be improved by increasing the length of the spurs and the number of eyes, leaving four or even five eyes to a spur according to the variety of vine.

THE LONG OR CANE PRUNING SYSTEM.

The long or cane pruning system is also in general use in California. When vines are trained according to this system the fruit is borne on canes which are tied to a stake as shown in figure 29, the spurs which are left to grow from them producing canes for the following year. In pruning, the canes which fruited the previous year as well as the arms on which they grew are entirely removed, the canes produced from the spurs left the previous year furnishing the fruiting canes and spurs needed. In this manner the head of the vine is renewed from year to year, and as the plants grow older and stronger the fruiting capacity is increased by leaving more canes and spurs. Figure 13, *A*, shows a vine at the end of the second year; figure 30, at the end of the third year; and figure 29, at the end of the fifth year, pruned according to this system.

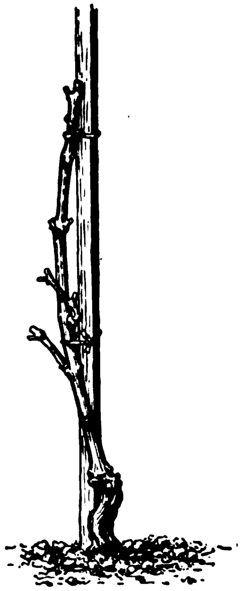

FIG. 30.—A pruned vine in its third year, showing the method of training by the cane system.

THE PRINCIPAL GRAPE REGIONS OF THE UNITED STATES.

There are three distinct viticultural regions in the United States which segregate themselves by the grape species grown in them.

The Vinifera region, in which Vinifera varieties are almost exclusively grown, is located almost entirely west of the Rocky Mountains, so much of it being in California that those not conversant with grape varieties erroneously call them California grapes. With few exceptions either the spur, stool, or short pruning system is used for the stockier growing varieties, and the long or cane pruning system is usually used for the longer growing varieties, but either system is often modified to suit individual varieties. Thus the spurs are sometimes left longer in the spur system, and either spurs and canes left longer or spurs cut on the laterals in the cane system.

Stakes only are used to give the vines the necessary support; this method allows the vineyard to be cultivated crosswise as well as lengthwise.[1] Vines trained on trellises are comparatively rare in California.

The more generally known Vinifera varieties grown in this district are the Alexandria, Alicante Bouschet, Aramon, Burger, Cabernet

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[1] "See Grape, Rasin, and Wine Production in the United States," Yearbook, U. S. Dept. of Agriculture, for 1902.

Sauvignon, Calmette, Carignane, Chasselas de Fontainebleau, Cornichon, Emperor, Flame Tokay, Green Hungarian, Grenache, Malaga, Mission, Mondeuse, Mourestel, Pizzutella, Petit Syrah, Purple Damascus, Riesling, Semillon, Sauvignon Vert, Sultanina, Sylvaner, Valdepenas, and Zinfandel.

The Muscadine region of the South Atlantic and Gulf States includes the entire southeastern coastal plain extending from the Potomac to Florida, reaching well up into the Blue Ridge Mountains and along the Gulf coast to the Rio Grande River, spreading to the north along the Mississippi River into the great central plains to southeast Missouri and the Tennessee River. In this region improved varieties of the Rotundifolia and Munsoniana species are grown for various purposes, the better-known varieties of these being the Eden, Flowers, James, Mish, Scuppernong, and Thomas. The multiple cross-wire system or overhead arbor is almost exclusively used. As previously mentioned, these arbors are very similar to the overhead trellis or parrales system used in Spain with the Almerian varieties commonly seen in our markets packed in cork dust and called " Malaga " grapes.

The third or American native-grape region is the one in which improved varieties of the more northern native grape species and hybrids of them and the Vinifera species are grown. This region comprises all that part of the United States which lies east of the Rocky Mountains. Of late years a few plantings have also been made in parts of Oregon and Washington, but the industry is most extensive in the States west of the Hudson River and north of the Ohio River that border on the Great Lakes and in the more centrally located States of the Mississippi Valley. In this district the high-renewal, horizontal-arm spur, horizontal block, fan, Hudson horizontal, four-cane Kniffin, umbrella or two-cane Kniffin, Munson, overhead Caywood, and Chittenden systems are used, the localities in which they originated or are most common being stated in the description of the various systems. The varieties most extensively grown are the following: Agawam, America, Barry, Beacon, Berckmans, Brighton, Brilliant, Campbell, Carman, Catawba, Champion, Clinton, Concord, Cottage, Cynthiana, Daisy, Dawn, Delaware, Diamond, Diana, Duchess, Eaton, Elvicand, Elvira, Empire State, Fern, Gold Coin, Gaertner, Goethe, Headlight, Herbemont, Herbert, Iona, Isabella, Ives, Jaeger, Janesville, Jefferson, Lady, Laussel, Lenoir, Lindley, Lutie, Martha, Massasoit, Merrimac, Missouri Riesling, Moore, Muench, Nectar, Niagara, Noah, Norton, Olita, Perkins, Perry, Pocklington, Prentiss, Rommel, Salem, Triumph, Ulster, Vergennes, Victor, Washington, Wilder, Winchell, Wetumka, Woodruff, Worden, and Wyoming.

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Issued October 7, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 372.

SOY BEANS.

BY

C. V. PIPER,
Agrostologist in Charge,

AND

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Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., June 30, 1909.

Sir: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin, to supersede Bulletin 58 of the same series, the accompanying manuscript on "Soy Beans," prepared by Prof. Charles V. Piper, Agrostologist in Charge, and Mr. H. T. Nielsen, Scientific Assistant, Forage Crop Investigations.

The soy bean has become a crop of special importance in several Southern States, and interest in it has greatly grown during the past few years. At the present time there is great interest in the crop owing to the possibility that it may be grown on an extensive scale in regions where the boll weevil has rendered the returns from cotton culture uncertain. The recent enormous exportations of soy beans and soy-bean meal from Manchuria to Europe would seem to indicate that there is practically an unlimited market for this product. It is now believed that by the selection of proper varieties, of which the number is very large, the soy bean can be profitably grown in practically all parts of the cotton belt as a grain crop.

It is especially desirable to publish this bulletin at the present time in order that the possibilities of the crop may be generally understood.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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SOY BEANS.

INTRODUCTION.

The soy bean, also called the "soja bean" (fig. 1), is a native of southeastern Asia and has been extensively cultivated in Japan, China, and India since ancient times. Upward of two hundred varieties are grown in these countries, practically every district of which has its own distinct varieties. The beans are there grown almost entirely for human food, being prepared for consumption in many different ways. Their flavor, however, does not commend them to Caucasian appetites and thus far they have found but small favor as human food in either Europe or America.

As a forage crop, however, soy beans have become of increasing importance in parts of the United States, especially southward. They have been tested at most of the State agricultural experiment stations, and it is clear that their region of maximum importance will be south of the red-clover area and in sections where alfalfa can not be grown successfully. They thus compete principally with cowpeas, but as cultiva-

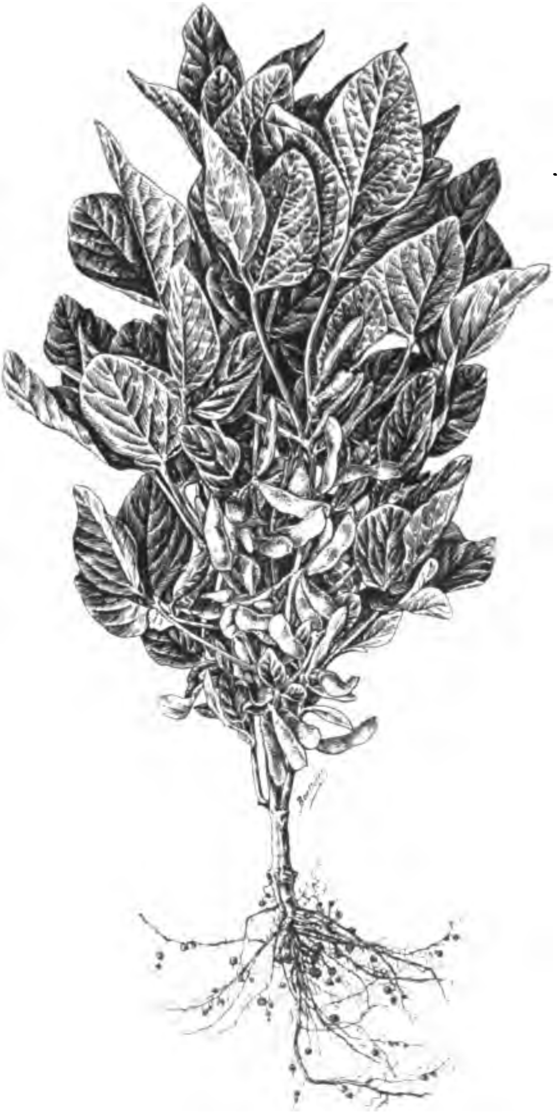

FIG. 1.—Typical soy-bean plant.

tion is usually required they fill a somewhat different agricultural need. Their culture has greatly increased in recent years, especially in Tennessee, North Carolina, Virginia, Maryland, Kentucky, and the southern parts of Illinois and Indiana. It seems certain that the crop will become one of great importance in the regions mentioned and probably over a much wider area. The earlier varieties mature even in Minnesota, Ontario, and Massachusetts.

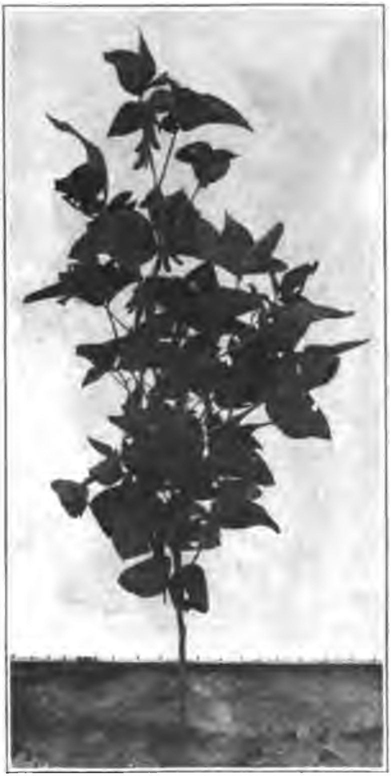

FIG. 2.—A plant of the Mammoth variety of soy bean, showing its characteristic habit of growth. Height, 40 inches.

As a hay plant the soy bean can not successfully compete with red clover or alfalfa. Unless the yield of grain is 15 bushels or more per acre it is hardly profitable enough to grow it for that purpose alone, as it would be too expensive to feed. Some of the early varieties will yield 16 to 20 bushels or more per acre, and where such yields can be secured the crop is a valuable one.

CLIMATIC AND SOIL REQUIREMENTS OF SOY BEANS.

The soy bean is especially adapted to the cotton belt and northward into the southern part of the corn belt. The early varieties mature in the northern part of the corn belt, but frequently do not make a sufficient yield to warrant growing them. Farther south, where the later and larger varieties can be grown, the yield is sufficient to make their extensive cultivation very profitable. Generally speaking, the soy bean requires about the same temperature as corn. It is perhaps even better adapted to a warm climate and does not do well in a cool climate.

The soil requirements of soy beans are much the same as those of corn. They will make a satisfactory growth on poorer soil than corn, provided inoculation is present, but will not make nearly as good a growth on poor soil as cowpeas. Soy beans make their best development on fairly fertile loams or clays. The Mammoth variety (fig. 2) also succeeds well on sandy soils. On rich soils all varieties are apt to make a large plant growth and a comparatively small yield of seed, and on the poorer soils a small plant growth with a relatively large seed yield.

Soy beans do not require a well-drained soil for their best development, although they will not grow in a soil where water stands for any considerable length of time. However, they are able to withstand a greater amount of moisture than either corn or cowpeas. In eastern North Carolina on the vegetable mold soils they make excellent crops. On this account soy beans are especially valuable for growing in that region, since the heavy rainfall is the main drawback.

Soy beans are also decidedly drought resistant, much more so than cowpeas, and but for the depredations of rabbits would be a valuable crop in the semiarid West. Rabbits are exceedingly fond of the foliage, and where they are numerous it is nearly useless to plant soy beans unless the field can be inclosed with rabbit-proof fencing.

VARIETIES OF SOY BEANS.

At the present time seven varieties of soy beans, Mammoth, Hollybrook, Guelph, Ito San, Buckshot, Ogemaw, and Wisconsin Black, are handled by American seedsmen. (See fig. 3.) During the past three years more than two hundred additional varieties have been introduced from China, Japan, and India, most of which have already been sufficiently tested to give some idea of their value. Many of the new varieties are so superior in various respects that they are certain to replace all of the above-named varieties except the Mammoth and, perhaps, the Ito San.

The matter of variety is of special importance in soy beans, as many growers have been sorely disappointed in getting a small early variety when they desired a larger and later sort. As this difficulty occurs when there are at most seven varieties handled by seedsmen, it can readily be seen that there is the possibility of greater confusion with the introduction of more varieties. On this account it is very desirable to keep down to the minimum the number of varieties introduced into the seed trade, and these the very best sorts. Seedsmen are urged to use the varietal names here adopted, and buyers should be very careful to specify the variety wanted.

MAMMOTH (YELLOW).

The Mammoth variety (see figs. 2, 3, 4, and 5) is the largest growing and latest of the soy beans at present handled by seedsmen. Under average conditions it will grow from 3 to 5 feet high, depending principally on the character of the soil. (See fig. 4.) Ordinarily it requires from 120 to 150 days to mature a crop of seed. The Mammoth yields well in both grain and roughage and is satisfactory for both. It is a most exacting variety about depth of planting, and under no circumstances should the seed be planted more than 2 inches deep. The habit of growth is such that it can readily be

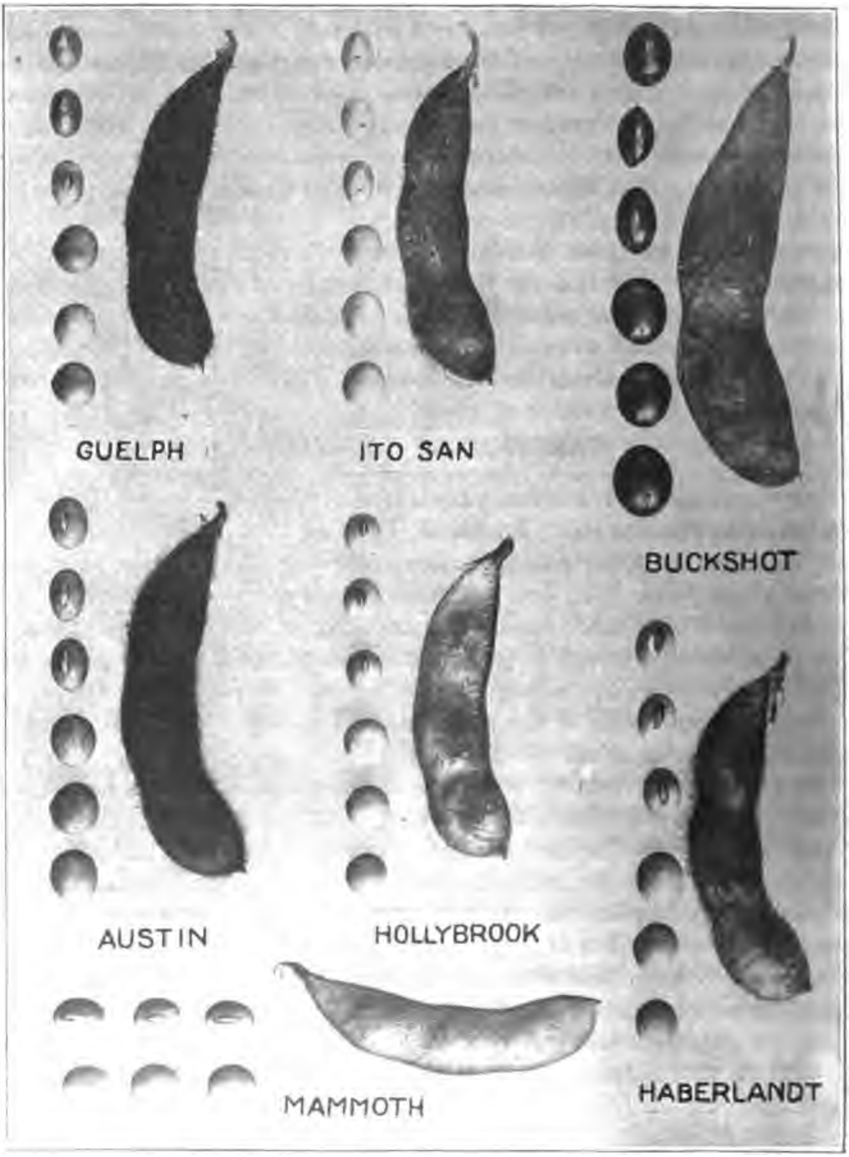

FIG. 3.—Seeds and pods of seven varieties of soy beans. Natural size.

harvested with machinery and it is frequently gathered with a grain binder. It is well adapted to nearly all of the country south of the northern boundary of Tennessee and can be grown quite successfully some distance north of this, though not as far north as Washington, D. C.

HOLLYBROOK (YELLOW).

The Hollybrook variety is about two weeks earlier than the Mammoth and seldom grows to a greater height than about 3 feet. It is very coarse and woody and therefore not desirable for hay, but it yields large crops of grain. The seed is very nearly identical with that of the Mammoth. The lower branches and pods are apt to be very near the ground, and there is consequently some difficulty in harvesting this variety. It can be grown farther north than the Mammoth, but is not nearly so valuable a variety.

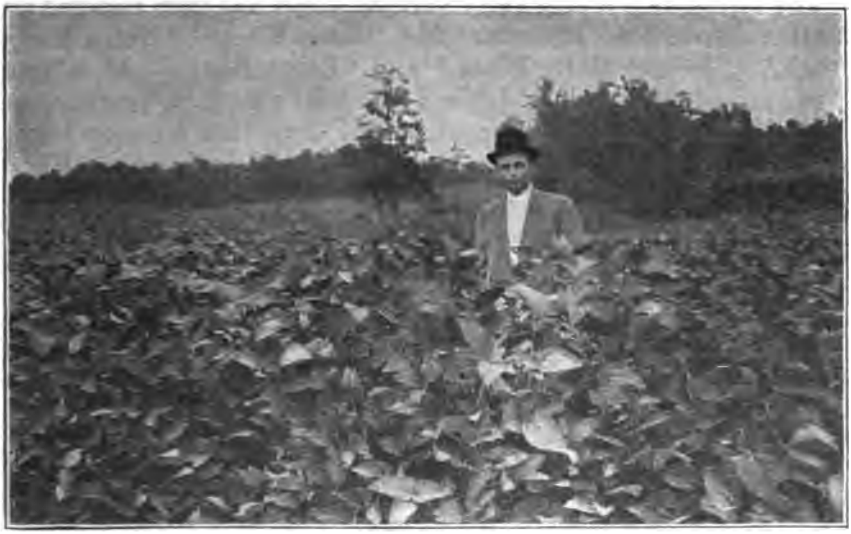

FIG. 4.—A field of the Mammoth variety of soy bean in North Carolina.

ITO SAN (YELLOW).

The Ito San soy bean has been very commonly grown, appearing under the names "Yellow," "Early Yellow," "Medium Yellow," and "Early White," as well as "Ito San." The plants are of medium size, averaging about 30 inches in height, with numerous ascending slender branches, so that this variety can be mown very satisfactorily. It has fine stems and makes excellent hay, though the yield is only moderate. It produces seed fairly well and matures in from 95 to 100 days. It is a very satisfactory variety to grow in a short season or after a small-grain crop. The seed, which is about the same size as that of the Mammoth, can always be identified by a little brown speck at one end of the hilum, or seed scar. This variety will mature as far north as southern Wisconsin and southern Michigan.

GUELPH (GREEN).

The Guelph soy bean has been advertised more than any other variety, appearing with such names as "Medium Green," "Medium Early Green," and "Large Medium Green." It grows about as large as the Hollybrook variety and matures about 10 days later than the Ito San. The leaves drop without changing color when the plant ripens. The plant is very coarse and not satisfactory for hay. While the seed yield is heavy the pods shatter very much. On these accounts the Guelph is not a desirable variety.

BUCKSHOT (BLACK).

The Buckshot is a very early variety, which has been handled by northern seedsmen. It is also called "Early Black," "Extra Early Black," "Medium Early Black," and "Large Black." It seldom grows more than 24 inches high and is at least a week earlier than the Ito San variety. The seed is considerably larger than ordinary buckshot, but has the same shape. The plants are entirely too small and coarse and produce pods too near the ground to be of much value. If the Buckshot variety is planted at all it should be only in the northern tier of States.

OGEMAW (BROWN).

The Ogemaw is even earlier than the Buckshot variety, and is also a smaller grower and less satisfactory. The seed, which is about the same size as that of the Buckshot variety, can sometimes be purchased from northern seedsmen.

WISCONSIN BLACK.

The Wisconsin Black is an early black-seeded variety that is grown to some extent in Wisconsin and Michigan. Its earliness is its principal merit.

The following new varieties are the best out of more than one hundred sorts tested. They are not yet in the market, but most of them will be available in 1910.

WILSON (BLACK).

The Wilson is a tall variety, growing 3 to 4 feet high, with few erect branches, maturing about one week later than the Ito San. Owing to its tall habit and lack of basal branches it can be harvested easily. It is a heavy grain yielder and also excellent for hay. This variety should be very valuable in such States as Illinois, Indiana, and Ohio, replacing the Guelph variety especially.

MEYER (MOTTLED BLACK AND BROWN).

The Meyer variety is excellent for hay, as it is tall and has fine stems and branches. During the past three years it has given larger yields of seed than any other variety under trial at the Arlington Experimental Farm in Virginia. Its tall habit makes it easy to mow, but unfortunately it is somewhat inclined to lodge. It matures in 110 days. The seeds are large and break rather easily in thrashing.

AUSTIN (GREENISH YELLOW).

The Austin is a vigorous though not coarse medium-late variety, growing 3 to 4 feet high, with numerous branches but none close to the ground. It can be easily harvested with machinery and is an excellent seed producer.

HABERLANDT (YELLOW).

The Haberlandt variety requires about one week's more time in which to mature than does the Ito San. The seed is considerably larger than that of any of the other yellow-seeded varieties and has a distinctly brown hilum, or seed scar. It is a very heavy yielder of seed, but is rather stocky, seldom growing to a greater height than 30 inches. It can be harvested fairly well with a mower and will give better results than the Ito San variety in many places. Under the conditions in Tennessee it has proved very satisfactory and is strongly recommended there when an earlier variety than the Mammoth is desired.

RICELAND (BLACK).

The Riceland is a soy bean which requires a very long season in which to make its full development, and is therefore adapted only to the cotton belt. The seed is rather small, long, and flat, and covered with a powdery bloom which makes it look dusty. The plants grow from 4 to 6 feet high, but have fine stems and consequently are of a very desirable type for hay.

THE CULTURE AND PLANTING OF SOY BEANS.

Good preparation of the soil is necessary for soy beans; otherwise weeds are likely to choke out the young plants. This preparation should consist of deep plowing and subsequent working with disk and harrow until a firm seed bed, with the upper 2 or 3 inches loose and mellow, is secured. Under nearly all conditions the crop should be grown in rows and given sufficient cultivation to keep down weeds. If the ground is exceptionally free from weeds soy beans may be sown broadcast or drilled with the idea of using them for hay. The yield of seed is nearly always greater when grown in cultivated rows.

Soy beans if in rows should be planted so as to have a plant on an average of every 2 or 3 inches in the row and the rows from 30 to 36 inches apart. Cultivation can be more easily accomplished if the rows are 36 inches apart than where the distance is less, though the plants have room for development in 28-inch rows. In eastern North Carolina soy beans are planted in rows 4 feet apart and hilled as high as possible to aid in drainage, which is very important in that region.

It is especially important to plant seed of good quality. Soybean seed unless it is fresh and has been properly stored is very apt to be low in germination. It should therefore be tested for viability before planting time. The planting should be shallow, preferably 1 inch and not to exceed 2 inches in depth. Poor stands result more frequently from too deep planting than from any other cause. A bushel of good seed is sufficient to plant from 2 to 3 acres if in cultivated rows, and hardly enough for 1 acre if sown broadcast.

The cultivation of soy beans is a simple matter. Unless conditions are very unfavorable the seedling plants appear above ground in a week and tillage may then begin. Any good cultivator may be used, and flat cultivation is preferable, as the harvesting can be more easily done than if the rows are hilled or ridged.

Soy beans may be planted through a wide period from early spring till midsummer. Ordinarily they are planted about June 1. In the lowlands of Tennessee and North Carolina and southward two crops of the early and medium varieties may be secured in a season. In general, early plantings require more time to mature than late plantings, the difference in the same variety often amounting to as much as three weeks.

THE INOCULATION OF SOY BEANS.

Like other legumes, soy beans are able to utilize the nitrogen of the air and add it to the soil by means of root nodules. These nodules (fig. 5) are caused by certain bacteria; unless they are present soy beans in the usual types of soil will make but a weak growth, and many of the plants will turn yellow and die.

Throughout the South the proper bacteria for soy beans seem to be widely distributed, so that natural inoculation now occurs generally. In isolated localities where this crop has not been grown, however, some difficulty may be expected from lack of inoculation during the first season at least. Northward and westward greater difficulty in this regard is experienced.

Inoculation of a new field may be secured either by the soil-transfer method or by the use of the pure cultures prepared by the Department of Agriculture. The soil-transfer method consists in scattering soil from an old, well-inoculated soy-bean field over the new ground at the rate of 200 to 300 pounds per acre. To facilitate even scattering this should be thoroughly mixed with several times its weight of ordinary soil. The soil may be either drilled or broadcasted. In the latter case it should be done toward evening or on a cloudy day, as bright sunshine is very harmful to the germs. The objections to the soil-transfer method are the labor and cost involved and the serious

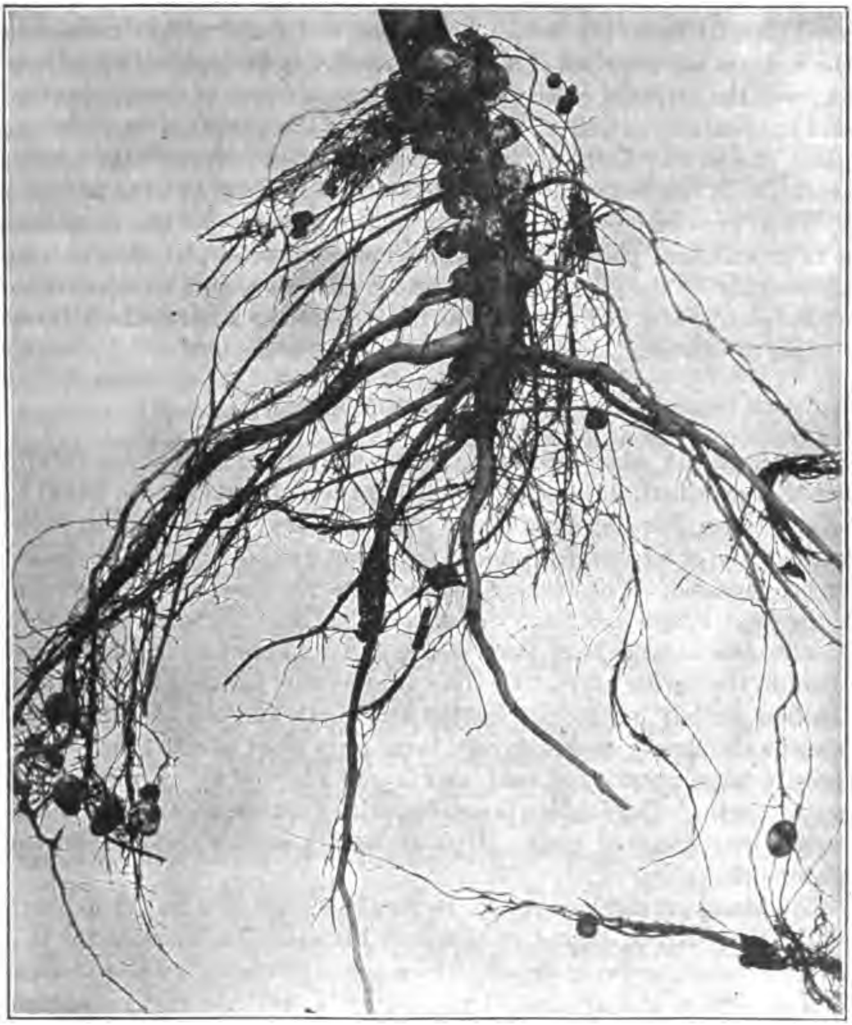

FIG. 5.—Roots of a plant of the Mammoth variety of soy bean, showing characteristic nodules.

liability of spreading weeds and dangerous plant diseases. Successful inoculation by this method is, however, practically certain.

The method of inoculation by means of the pure cultures prepared by the United States Department of Agriculture is fully described in Farmers' Bulletin 315. Fresh liquid cultures are sent out in sealed bottles, and for small quantities of seed the culture may be diluted and used directly upon the seed. Directions and material for increasing the culture are supplied if a larger quantity is desired. The advantages of the artificial cultures lie in the greater ease of transportation and application, as well as in the absence of the danger of introducing plant diseases or harmful weeds. This method is frequently unsuccessful with soy beans, due possibly to the oily nature of the seeds.

When growing soy beans or any of the legumes for the first time it is an excellent plan to plant a small experimental plat, inoculating thoroughly by the pure-culture method. If this plat is successful, an abundance of soil will be available for inoculating large fields without danger of introducing weeds or diseases.

SOY BEANS FOR HAY.

Soy-bean hay when cut at the proper stage of growth and carefully cured is excellent, and for dairy cattle at least yields results equal to alfalfa hay. For hay production soy beans may be planted in cultivated rows, or when the ground is free from weeds they may be drilled or broadcasted. The late or medium-late varieties are as a general thing best adapted for hay production. These varieties grow to a greater height and have finer stems and branches and more leaves than do the earlier sorts. Of the varieties now handled by seedsmen the best for hay production are the Mammoth and the Ito San. The Mammoth variety makes a very large growth of plant, usually produces a large quantity of seed, and is well adapted for growing in the entire South. The Ito San is smaller, with finer stems, and also yields satisfactory crops of grain. It is at least a month earlier than the Mammoth.

Soy beans are not as a rule to be recommended as a hay crop north of the Ohio River, except in southern Illinois. The reasons for this are the shorter growing season, which tends to encourage the production of seed at the expense of plant growth, and the general culture of red clover, with which soy beans can scarcely compete in the production of hay. To get the best hay from soy beans they should be cut when half or more of the pods are fully grown, but before they begin to change color in ripening. Another rule, which is probably the better one to follow, is to cut when the top leaves begin to turn yellow. This is the best guide in most cases, but does not always apply, as some varieties, notably the Guelph, shed their leaves without change of color. At this stage of growth the largest yield and at the same time a good quality of hay will be secured. If the cutting is done earlier than this, the percentage of protein will be higher and there will be practically no waste in feeding; but the total yield will not be so large and the difficulty of curing much greater. If the cutting is much later than this, the total food constituents will be greater, but there will also be considerable waste of material in feeding due to the stems becoming hard and woody.

CURING THE HAY.

The planting should be timed, so that the crop can be cut for hay in September, as this month is usually the most satisfactory for haymaking. The cutting may begin as soon as the dew is off the plants and continue for the rest of the day. The plants should be allowed to lie in the swath until the leaves are well wilted, but great care should be exercised to rake them before the leaves become dry and brittle. After raking into windrows they should be left for a day or two, depending on the weather, and then put in small cocks or bunches. Three to five or six days of good weather is ample time for making good soy-bean hay. Great care should be used to prevent the loss of leaves, since these are the most valuable part of the plant except the pods.

When the hay is dry, it should be put in good-sized stacks or under a shed. If it is stacked in the open field it is very essential that some other material, either grass or a canvas cover, be put over the stack, as soy-bean hay does not shed rain well. Yields of from 1 to 3 and occasionally 4 tons of cured hay to the acre are secured. The average yield is about 2 tons per acre.

Curing frames can often be used to good advantage in making soy-bean hay, especially in unfavorable weather. The object of these frames is to keep the cocks open, so as to prevent matting and to allow the circulation of air. They are usually three or four sided pyramids made of boards or poles 3 to 6 feet long, fastened together at the top and held by crosspieces near the base. By this device a hollow cock or shock is secured, and consequent better curing.

In stacking the hay, poles or logs placed in the center of stack, so as to leave passages for air, will greatly lessen the danger of spoiling.

SOY BEANS FOR PASTURAGE.

The soy-bean crop can often be profitably utilized by pasturing, particularly to hogs, especially when fed corn in addition. This is advisable when harvesting is interfered with by lack of labor, bad weather, or other causes and when the crop is grown especially for soil improvement. By this means not only is the crop profitable in itself, but the manure is returned to the soil. The usual practice is to turn the hogs into the soy beans when the pods are nearly full of grain, but before they have begun to ripen. In pasturage experiments conducted at the Alabama Agricultural Experiment Station,[a] the following crops as pasturage for hogs were compared: Soy beans, peanuts, chufas, and sorghum. In these experiments it was found that when corn alone was fed 100 pounds of pork cost $7.63; when fed a two-thirds ration of corn and pastured in addition 100 pounds of pork cost $8.89 when on chufa pasture, $7.79 on sorghum pasture, $3.20 on peanut pasture, and $2.74 on soy-bean pasture. The average gain of the pigs each day on the soy-bean pasture was 1.02 pounds, on the peanut pasture 1.01 pounds, on the chufa pasture 0.72 pound, and on the sorghum pasture 0.37 pound. In this experiment the hogs were turned into the soy beans while the pods were very small, so that for two weeks they ate only the leaves and young shoots.

In a similar experiment conducted at the Arkansas Agricultural Experiment Station the effect of the legume crop grazed by hogs was determined on the two succeeding cotton crops as compared with cotton following corn not grazed. The figures show that the two cotton crops aggregated 2,905 pounds of seed cotton following peanuts grazed, 2,608 pounds following soy beans grazed, and only 1,802 pounds following corn not grazed.

SOY BEANS IN MIXTURES.

There has been but little experimenting as yet in growing soy beans in mixtures with other plants. What little has been done indicates that the soy bean may be satisfactorily grown in combination with a number of other agricultural crops.

SOY BEANS AND COWPEAS.

Soy beans and cowpeas make a very satisfactory mixture for hay purposes. The tall, strong-growing varieties of soy beans are to be preferred for this combination, as the cowpeas are vining plants and need something to hold them up so that they can be readily harvested. The hay of such a mixture is more desirable than the hay of either crop alone, as it affords variety. The yield also is nearly always greater. There is no doubt that most live stock prefer the soy beans to the cowpeas in this mixed hay, but both plants are eagerly eaten by practically all kinds of farm stock.

In sowing soy beans and cowpeas in mixture about 1 bushel of the former to a half bushel of the latter per acre should be used. If planted in rows, about one-half of this quantity of each is sufficient. It is necessary to have more soy-bean plants than cowpeas, so that the vining growth of the cowpeas may be supported properly. The Mammoth and Hollybrook varieties of soy beans are preferable. The Whippoorwill and Iron varieties of cowpeas are good.

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[a] Bulletin 143, Alabama Agricultural Experiment Station, 1908.

There has been considerable difficulty experienced in getting a stand of the soy beans when grown in mixture with cowpeas. This is mainly due to putting the seed in the ground too deeply, a point which should be kept constantly in mind in planting soy beans. The planting can be done best with an ordinary grain drill, whether it is to be in cultivated rows or sowed.

The curing of a mixture of cowpea and soy-bean hay is more easily accomplished than the curing of cowpeas alone, and slightly more difficult than in the case of soy beans alone. The time to cut will necessarily depend on the relative stage of growth of the two crops. As nearly as possible, both plants should be at the best stage of growth for haymaking when the harvesting is done. This time is when about half of the soy-bean pods are fully grown and just beginning to ripen and the first pods of the cowpeas are ripe. At this stage of growth they will make a hay the quality of which is hardly surpassed by any other produced on the farm.

SOY BEANS AND SORGO.

The soy bean may be grown in mixture with sorgo (sweet sorghum). There is some objection to the mixture when broadcasted, as the sorgo is apt to choke out the soy beans. When grown together in cultivated rows, this objection is largely overcome. Amber sorgo is usually the best variety for use.

SOY BEANS AND MILLET.

Some of the earlier varieties of soy beans have been grown with German millet. The mixture is not a good one, as the millet matures long before the soy beans.

SOY BEANS AND CORN.

Soy beans are more commonly grown with corn than with any other crop. They are planted in different sections in various ways, namely, in alternate hills with the corn in the same row, in alternate rows of each, in alternate series of two rows of each, or broadcasted in mixture. Such fields when planted in rows may be harvested for silage, or where the rows alternate the two crops may be harvested separately. Sometimes such mixed fields are utilized by pasturing to hogs. The early and medium varieties of soy beans may be planted in between the corn rows at the time of the last cultivation.

SOY BEANS FOR ENSILAGE.

The growing of soy beans for ensilage has not been practiced very extensively. In a number of instances ensilage has been made of the crop, usually in combination with corn, and it is invariably reported as making an excellent succulent feed. Only the larger late-growing varieties are desirable for this purpose. Some have tried growing soy beans in the corn rows or between the corn rows, planting them the same as cowpeas are planted in the cornfields of the South, while others prefer growing corn and soy beans in separate fields and when the ensilage is put up to mix them in the cutting. Where the soil and climate will permit, it would seem to be more satisfactory to grow the soy beans in the cornfield. It is doubtful whether it will be economical to make ensilage of soy beans when hay can be made with comparative ease. Corn deteriorates so much more rapidly in the shock than do most of the crops which can be made into hay that if ensilage is to be made on the farm the more economical practice will likely be to use the corn crop for this purpose and save the other crops for hay.

SOY BEANS FOR GRAIN.

Growing soy beans for the grain for use as feed is distinctly profitable if the yield is 16 bushels or more per acre. The feeding value of the grain is very high, being slightly superior to cotton-seed meal. The grain is rich in protein, while nearly all the other grains produced on the farm are poor in protein, but rich in carbohydrates.

For grain production tall varieties that do not branch or bear pods close to the ground are desirable, as they are more easily harvested. Of the varieties now on the market the Mammoth and Hollybrook are undoubtedly much the best for the South, while the Ito San and the Guelph, which is also known to the trade as Medium Green, are best for more northerly latitudes. A very serious objection to the Guelph, however, is its great tendency to shatter seeds at ripening time.

When grown for grain alone, the cutting may be delayed in the case of most of the varieties until all of the leaves have fallen. The Guelph and a few other varieties not on the market retain the leaves late and much seed would be lost by shattering if the harvesting were not done earlier. The plants should be allowed to become thoroughly dry after cutting before they are stacked or put into a barn or shed. Care should be taken, however, not to let them get too dry before they are piled into bunches, as there is likely to be considerable shattering of seed in such cases, especially if rained upon.

Thrashing is most satisfactorily done in the field without previous stacking, if conditions will permit. It is hardly possible under most conditions to harvest the crop without getting a certain quantity of soil mixed with it, and if the thrashing is done outside the resulting dust is not nearly as troublesome as when done inside. The fine hairs on the stems and pods also make a disagreeable dust in thrashing.

Harvesting may also be done when the leaves first begin to fall, getting in this way practically as much seed as when the plants are allowed to mature, and besides saving all the leaves. Such straw is much more valuable as feed than the stems alone, though stock will eat both readily. This last method is undoubtedly the most profitable way of handling the soy-bean crop if it is grown as forage for farm live stock. One field in eastern Tennessee produced in this way 25.5 bushels of grain and nearly 2 tons of straw to the acre. The Mammoth variety in a number of tests at the Tennessee Agricultural Experiment Station averaged nearly 20 bushels per acre and 1½ tons of straw when grown in acre plats.[a]

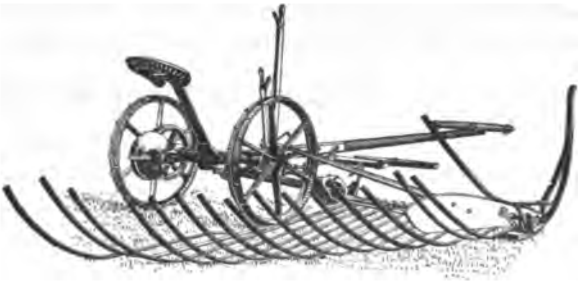
FIG. 6.—A bunching attachment on an ordinary mower.

One of the principal drawbacks in growing soy beans for seed has been the harvesting. The small early varieties can be harvested only with a mowing machine or a bean harvester, or by hand. The bean harvester has not given very satisfactory results. The mowing machine is apt to cut many of the lower pods in two and even leave some of them on the stubble. Hand work is too laborious and expensive. Many of the later and more erect-growing varieties can be satisfactorily harvested with a mowing machine or a drop-rake reaper, and the taller varieties even with a self-binder. The self-binder is the most satisfactory machine to use with tall varieties. With lower varieties the drop-rake reaper is recommended. This machine will leave the crop in small bunches which can easily be gathered. As the drop-rake reaper will cut as low as a mowing machine it is preferable to a mower. It can also be used very satisfactorily for harvesting cowpeas. On a small farm the drop-rake reaper is perhaps too expensive to justify purchasing, but here the mower with a side-delivery attachment can be made to answer the purpose. (Fig. 6.)

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[a] See Bulletins 78 and 80, Tennessee Agricultural Experiment Station.

SOY BEANS IN ROTATIONS.

Soy beans are admirably adapted to short rotations, taking either an entire season or a part of a season following some small-grain crop. In Tennessee and North Carolina a soy-bean crop is often grown between two wheat crops, and in other parts of the South between oat crops. In such cases, however, an early variety like the Ito San or the Haberlandt is preferable.

Where a whole season is devoted to soy beans two crops of the earlier varieties can be matured in all parts of the cotton belt, and this is in many cases preferable to growing a single crop of a late variety. Where the whole season is thus devoted to soy beans, they may take any place in a rotation system where corn can be used.

The consensus of opinion among farmers is that a crop of soy beans benefits the succeeding crop, but not to so great a degree as one of cowpeas. More accurate data on this point are needed.

Regarding the fertilizer requirements of soy beans there are but few data available. Where fertilizers are used, the general practice is to use acid phosphate at the rate of 200 to 300 pounds per acre and muriate of potash at the rate of 50 pounds per acre.

FEEDING VALUE OF SOY BEANS.

The feeding value of any forage crop and for any particular purpose can be determined only by actual feeding experiments. There are, of course, definite relations between the digestible constituents of a feed and the resultant gains in flesh or milk. These relations are, however, more complex than a table of analyses indicates. On this account the relative value of feeds is best shown by comparative feeding trials. Such trials indicate that good soy-bean hay is about equal to alfalfa for milk and butter production. They also show that soy-bean meal is somewhat superior to cotton-seed meal in the production of pork, mutton, and milk. Soy-bean meal also proves to be slightly more valuable than wheat middlings in feeding hogs.

FEEDING VALUE FOR SHEEP.

The Wisconsin Agricultural Experiment Station[a] has tested the value of soy-bean seed for fattening lambs. In one experiment two lots of 10 lambs each were fed the same roughage. One lot received shelled corn and whole soy beans in equal proportions, while the other received the same quantities of shelled corn and whole oats. The average gain of each lamb during a period of twelve weeks was 16.3 pounds when soy beans constituted a part of the ration and but 13.7 pounds when oats were used. A pound of gain was produced on 6.11 pounds of grain and 7.11 pounds of roughage in the soy-bean ration, while 7.28 pounds of grain and 8.62 pounds of roughage were required on the oats ration.

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[a] Annual Reports, Wisconsin Agricultural Experiment Station, 1904 and 1905.

In another experiment the same rations were fed for twelve weeks to two lots of 9 lambs each. The lot receiving the soy-bean ration gained 119 pounds in weight and produced 95.1 pounds of wool, against 71 pounds increase in weight and a production of 81.3 pounds of wool for the lot receiving the oat ration. The second lot also consumed more feed per pound of gain.

FEEDING VALUE FOR DAIRY COWS.

Soy-bean meal has been found a most excellent feed for dairy cows. The Massachusetts Agricultural Experiment Station[a] compared soy-bean meal and cotton-seed meal, using the same ration otherwise. The quantity of milk produced from the soy-bean ration was slightly larger. The butter from the cows fed cotton-seed meal was of firmer texture, but not nearly as good otherwise as the butter from the cows fed soy-bean meal. The test indicated that soy-bean meal was superior to cotton-seed meal for both milk and butter production.

At the Tennessee Agricultural Experiment Station[b] three groups of cows of two lots each were fed to compare (1) soy-bean straw and corn stover; (2) soy-bean hay and alfalfa hay, and (3) soy-bean meal and cotton-seed meal. There was no chance in these experiments for the individuality of the animals to affect the results, as each lot was fed on the separate rations at different periods in the course of the experiments.

Soy-bean straw was found very palatable and superior to corn stover as a feed. More feed was eaten in the case of the soy-bean straw, but the cost of the feeds consumed during a thirty-day period was practically the same. The soy-bean ration produced 12 per cent more milk and 14 per cent more butter fat, so that the cost of a gallon of milk was 1.2 cents less and of a pound of butter fat 2.1 cents less than when corn stover was fed as roughage.

In the comparison of soy-bean hay and alfalfa hay, these substances were fed in combination with corn silage and corn-and-cob meal. Each lot of cows consisted of four Jerseys, and the test lasted through three periods of thirty days each. At the end of this time the results were in favor of the soy-bean hay by 245 pounds of milk and 20.5 pounds of butter fat. This result indicates a slight superiority of soy-bean hay over alfalfa hay.

In the trial for the comparison of soy-bean meal and cotton-seed meal the yield both of milk and of butter fat was about 5 per cent greater for the soy-bean meal.

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[a] Annual Report, Massachusetts Agricultural Experiment Station, 1893, pp. 13-14.

[b] Bulletin 80, Tennessee Agricultural Experiment Station, 1908.

FEEDING VALUE FOR HOGS.

The Wisconsin Agricultural Experiment Station[a] compared soy-bean meal and wheat middlings for pork production in three separate experiments in as many years. Two-thirds of the grain ration was corn meal in each case. In each of the experiments the largest gains were made on the soy-bean rations. Soy beans proved about 10 per cent superior to wheat middlings for pork production, figuring the cost of the feeds as the same.

The Indiana Agricultural Experiment Station[b] compared rations of 2 parts of corn meal and 1 part of soy-bean meal with corn meal and wheat middlings in equal proportions and with 5 parts of corn meal and 1 part of tankage for pork production. The soy-bean ration produced the largest daily gains, and this with the smallest quantity of feed consumed for each pound of gain.

The Kansas Agricultural Experiment Station[c] has several times tested the value of soy-bean meal in combination with corn meal and with kafir meal in comparison with the two latter feeds alone in feeding hogs. The feeds were mixed in the proportion of four-fifths corn or kafir and one-fifth soy beans. Larger gains, varying from 13 to 37 per cent, were made in every case on the mixed rations than on corn or kafir alone.

With corn meal alone 100 pounds of gain cost $3.92, with corn meal and soy-bean meal $3.73, and with kafir meal and soy-bean meal $3.37. For these computations the value of corn meal was fixed at $14 a ton, kafir meal at $13 a ton, and soy beans at $25 a ton, or 75 cents a bushel.

STORING SOY-BEAN SEED.

The storage of soy-bean seed requires special care. The grain should be thoroughly dry when put into storage or else placed where good ventilation is afforded; otherwise it is almost certain to heat and be ruined as far as germination is concerned. No matter what may be the condition of the seed at the time it is stored, it should be examined occasionally to detect any tendency to heat.

Even when soy-bean seed has been stored carefully the germination is apt to fall off rapidly. In fact, it is as a rule unwise to plant seed more than one season old without first testing it for germination. Unlike cowpea seed that of soy beans is rarely attacked by weevils.

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[a] Annual Reports, Wisconsin Agricultural Experiment Station for 1904, 1905, and 1906.

[b] Bulletin 108, Indiana Agricultural Experiment Station, 1905.

[c] Bulletin 92, Kansas Agricultural Experiment Station, pp. 24-25, and Press Bulletin No. 141, 1905.

COMPARISON OF SOY-BEAN GRAIN AND COTTON-SEED MEAL.

Throughout much of the region well adapted to soy beans dairy farmers purchase cotton-seed meal for a high-protein feed. Numerous experiments have shown that soy-bean meal is equal or slightly superior as a feed to cotton-seed meal both for cows and for hogs.

Yields of 20 bushels per acre of soy beans on lands of moderate fertility may confidently be expected in the region where the best medium or late varieties will mature. On the comparatively poor soils of the Arlington Experimental Farm in Virginia yields of the best varieties have been obtained in acre plats as follows: Acme, 29.7 bushels; Meyer, 23.6 bushels; Tashing, 23.3 bushels; Wilson, 23.1 bushels; Jet, 22.6 bushels; Ito San, 22.6 bushels; Guelph, 21.6 bushels; Flat King, 21 bushels. Similar, and in many cases larger, yields are reported by many farmers and by the agricultural experiment stations of Tennessee, Virginia, Delaware, New Jersey, Indiana, Wisconsin, Rhode Island, and Massachusetts. Yields of 40 to 50 bushels per acre have frequently been reported, and some writers have mentioned yields of 100 bushels per acre. It is doubtful whether yields of even 50 bushels per acre are made, except on small areas.

The above seed yields are comparable in value to those of wheat or corn, and the crop may come to be grown extensively as a money crop, especially in regions where the boll weevil makes cotton culture uncertain. For the present, however, the culture of soy beans is recommended mainly to those farmers who can feed the crop.

During the past ten years soy-bean meal has been imported into Europe in large quantities from Manchuria, and has met ready sale at a price above that of cotton-seed meal. This would seem to assure a market for practically unlimited quantities. Whether soy-bean oil would find an economic use comparable to that of cotton-seed oil remains to be determined, as does also the feeding value of soy-bean meal from which the oil has been extracted.

The relative richness of the soy bean in oil and other constituents as compared with other oily seeds is shown in the following tables:

TABLE I.—*Analyses of seeds of seven varieties of soy beans.*[a]

Variety.	Fresh or air-dry substance.					
	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Austin	8.67	36.59	20.55	24.41	4.00	5.78
Ito San	7.42	34.66	19.19	27.61	5.15	5.97
Kingston	7.45	36.24	18.96	26.28	4.79	6.28
Mammoth	7.49	32.99	21.03	29.36	4.12	5.01
Guelph	7.43	33.96	22.72	25.47	4.57	5.85
Medium Yellow	8.00	35.54	19.78	26.30	4.53	5.85
Samarow	7.43	37.82	20.23	23.65	5.05	5.82
Average	7.70	35.40	20.35	26.15	4.60	5.79

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[a] Bulletin 82, Tennessee Agricultural Experiment Station, p. 97. 1908.

TABLE II.—*Analyses of cotton seed, sunflower seed, and peanuts.*

Kind of seed.	Fresh or air-dry substance.					
	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
Cotton seed (whole):	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Minimum	8.00	12.62	10.40	7.58	17.60	2.80
Maximum	17.51	29.70	29.34	36.70	32.40	8.00
Average of 25 analyses	9.92	19.38	19.45	22.57	22.57	4.74
Sunflower seed (whole):						
Minimum	8.[illegible]	15.80	20.90	22.00	29.50	2.10
Maximum	8.[illegible]	16.70	21.50	20.70	30.30	3.20
Average of 8 analyses	8.60	16.30	21.20	21.40	29.90	2.60
Peanuts (kernels):						
Minimum	4.90	23.20	35.00	12.70	2.00	1.90
Maximum	13.20	31.50	47.40	19.10	18.40	3.80
Average of 7 analyses	7.50	27.90	30.60	15.60	7.00	2.40

COMPARISON OF SOY BEANS AND COWPEAS.

Inasmuch as the soy bean is adapted to nearly the same place in the farm rotation as the cowpea, a comparison of the two plants is pertinent.

The soy bean is determinate in growth; that is, it reaches a definite size and matures. Nearly all varieties of cowpeas, on the other hand, are indeterminate, continuing growth until killed by frost.

Soy beans, with the exception of a few varieties, do not vine, but grow erect or nearly erect. Cowpeas, on the other hand, are viny plants, and therefore more difficult to harvest.

Soy beans mature all their pods at one time. Cowpeas continue to produce green pods as long as the plant lives.

Soy beans will withstand quite heavy frosts, both in the spring, when young, and in the fall, when nearly mature, while the same frosts are fatal to cowpeas.

Soy beans are more drought resistant than cowpeas, and in a dry season will give much greater yields; they will also withstand excessive moisture much better.

For green manuring or soil improving, the cowpea is far more valuable than the soy bean, as it will smother weeds much more successfully.

The value of the hay of the two plants is nearly the same. There is frequently doubt as to which is the more desirable to grow. On relatively poor soil or when broadcasted cowpeas are always preferable. When cultivated, the soy bean will yield the greater return, and if cut late the hay is more easily cured.

For growing with corn or sorghum for hay or silage the cowpea is generally preferable to the soy bean.

The feeding value of an acre of soy beans for beef cattle was found by the Tennessee Agricultural Experiment Station to be about 50 pei cent greater than that of cowpeas grown on an adjoining acre. This was also approximately the difference in yield of the two crops.

As a grain producer the soy bean is in every way preferable to the cowpea, as it produces larger yields of richer grain and can be harvested much more easily.

The soy bean, therefore, is to be recommended above the cowpea where intensive rather than extensive farming is practicable and desirable.

SUMMARY.

(1) For intensive farming the soy bean is the best annual legume to grow for forage in the southern part of the cotton belt and into the southern part of the corn belt.

(2) The soy bean, whether used as hay, grain, straw, or ensilage, is very valuable as feed for live stock.

(3) Soy-bean hay is practically identical in feeding value with alfalfa and yields from 2 to 3 tons per acre. To make good soy-bean hay the crop must be cut when about half the pods are full grown or when the top leaves first begin to turn yellow.

(4) Soy-bean grain is more valuable than cotton-seed meal as a supplemental feed in the production of pork, mutton, wool, beef, milk, and butter. A bushel of soy beans is at least twice as valuable for feed as a bushel of corn. As the grain is hard it is usually desirable to grind it into meal for feeding. This is best done by mixing with corn before the grinding to prevent gumming up the mill.

(5) Harvesting ordinarily should be done when the leaves first begin to turn yellow, as the quality of the straw rapidly deteriorates thereafter and the yield of seed will be practically as large as at any later time. From 20 to 30 bushels of grain and 1½ to 2 tons of straw per acre are not uncommon.

(6) If soy beans are grown for the seed alone, and sometimes this is desirable, the harvesting can be done most easily by waiting until all the leaves have fallen.

(7) Soy-bean straw, if the crop is cut before the leaves fall, is fully as valuable for feeding as timothy hay for cattle, and is eaten by stock with much relish. Even when the harvesting is delayed until all the leaves have fallen, stock will eat the straw readily.

(8) Mixed with corn, soy beans are excellent for ensilage. The two crops may be grown together, but it is usually better practice to plant in separate fields and mix when putting into the silo.

(9) It is necessary to give the soil thorough preparation in order to be successful with soy beans. Only fresh seed or seed which has been tested for germination should be planted. Two-year-old seed is usually not reliable. The seed should be planted shallow, not to

exceed 2 inches in depth, and preferably in rows 30 or, better, 36 inches apart to permit sufficient cultivation to keep down weeds.

(10) For harvesting soy beans a mower with or without a side-delivery attachment, a self-rake reaper, or a self-binder can be used. A binder can be used only with the tall varieties. The thrashing can be done with a grain separator by using blank concaves and running the cylinder much slower than for small grains or by the use of machines specially designed for handling soy beans and cowpeas.

(11) Soy beans and cowpeas can be grown together satisfactorily; the hay of such a mixture is better than either crop alone and the yield is generally greater. In planting the two together the seed should not be covered too deeply, as deep planting will result in a poor stand of soy beans.

(12) As a crop in a short rotation soy beans are very desirable. They can be grown so as to use an entire season in the case of the late varieties, or two crops in one season can be secured from some of the earlier ones. They can also be used very advantageously to follow a small-grain crop the same season.

(13) The important commercial varieties of soy beans are the Mammoth, the Hollybrook, and the Ito San. Among the most valuable new varieties are the Austin, the Wilson, the Riceland, the Meyer, and the Haberlandt, most of which will be in the hands of seedsmen in 1910.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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Issued November 14, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 473.

TUBERCULOSIS.

A PLAIN STATEMENT OF FACTS REGARDING THE DISEASE, PREPARED ESPECIALLY FOR FARMERS AND OTHERS INTERESTED IN LIVE STOCK,

BY THE

INTERNATIONAL COMMISSION OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION ON THE CONTROL OF BOVINE TUBERCULOSIS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 27, 1911.

SIR: I have the honor to transmit herewith the manuscript of a treatise on tuberculosis, prepared by an international commission of the American Veterinary Medical Association on the control of bovine tuberculosis. This paper has been written with the object of placing before farmers and stock raisers a simple and concise statement of the principal facts about this disease. Coming from a representative body of men who combine both scientific and practical knowledge, it may well be regarded as an authoritative presentation of the subject. I respectfully recommend that it be published in the Farmers' Bulletin series of this department.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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TUBERCULOSIS.

A PLAIN STATEMENT OF FACTS REGARDING THE DISEASE.

Tuberculosis is a widespread disease affecting animals and also man. Human beings and cattle are its chief victims, but there is no kind of animal that will not take it. Hogs and chickens are quite often affected; horses, sheep, and goats but seldom, while cattle are the most susceptible of all animals.

NATURE OF THE DISEASE.

Tuberculosis is contagious, or "catching." It spreads from cow to cow in a herd until most of them are affected. This may not attract much notice from the owner, as the disease is slow to develop and a cow may be affected with it for several months and sometimes years before any signs of ill health are to be seen.

This slow development is the chief reason for the great loss it causes to the farmer. He does not suspect its presence in his herd until perhaps a large number are diseased. If the disease developed rapidly and caused death in a few days, the owner would soon take steps to check its progress and protect the rest of his herd. Tuberculosis is slow and hidden in its course and thus arouses no suspicion until great damage is done.

HISTORY.

Where did tuberculosis come from? We do not know. History records it from the earliest times.

Over a century ago its contagious nature was suspected and many facts were recorded to prove that it must be "catching." Doctors differed about it and for a long time the question was hotly disputed. Finally it was settled by Dr. Robert Koch, a distinguished German physician, who discovered the germ of the disease in the year 1882, and named it *Bacillus tuberculosis.* He proved by experiment that the disease is produced by these germs and without them the disease can not be produced. It is now universally admitted that tuberculosis is a contagious disease and may be transmitted from animal to man.

In America the disease was introduced with early importations of cattle and has been with us ever since. Modern methods of transportation by rail and water have spread the disease from one end of the continent to the other. No part of the country is entirely free from it, but it is more prevalent near the great centers of population than in the remoter parts.

IMPORTANCE.

The importance of the disease must be estimated from two points of view, first, the loss it entails upon the cattle owner, and, second, the danger of communication to human beings.

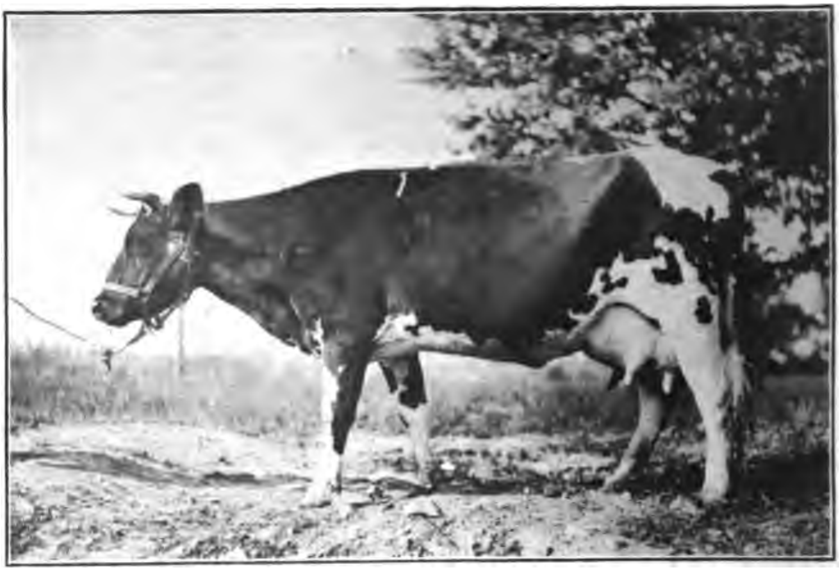

FIG. 1.—An apparently healthy cow affected with tuberculosis. She does not cough, her appetite is good, she seems strong and vigorous, and gives an unusually large quantity of milk. At the time the picture was taken it was known that she had been tuberculous at least four years and that she had been passing large numbers of tuberculosis germs from her body at least three years. Since it first became known that the cow was diseased she has given birth to four calves.

Consider first its effect upon the pocket of the owner of cattle, whether farmer, breeder, or dairyman. A serious percentage of the dairy cows of the continent are affected, and the disease is found in even a larger percentage of dairy herds. The disease is commoner in some regions than in others.

It is no uncommon thing to find as many as 70 or 80 per cent of the cows in a herd diseased. These animals will be in various stages of the disease, some recently infected showing no sign of ill health, others badly diseased, but outwardly appearing healthy, while a few are evidently breaking down and wasting away.

The loss to the owner is evident when a cow dies of the disease, or when an apparently healthy cow is slaughtered for beef and found so badly affected as to be unfit for food.

The calves in such a herd do not long remain healthy. They catch the disease before they are many months old and are a source of loss instead of gain.

Although the disease is most frequently found in herds that are more or less closely confined, such as dairy herds and purebred cattle, other herds are by no means free from it. Even range cattle are sometimes affected, and the infection spreads in spite of the open-air life of the cattle.

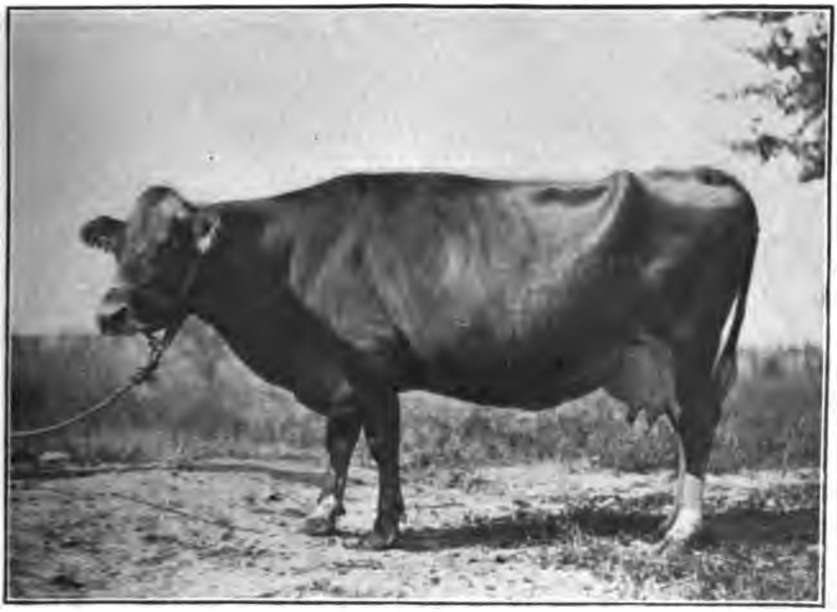

FIG. 2.—An apparently healthy cow affected with tuberculosis. She does not cough, her appetite is good, she gives a large quantity of milk, and is in excellent general condition for a dairy cow. At the time the picture was taken it was known that she had been affected with tuberculosis at least four years and that she had been passing tuberculosis germs from her body at least three years. The mixed dung of this cow and of the cow shown in figure 3 caused tuberculosis in hogs that were permitted to eat it.

Tuberculosis is common among hogs. The public abattoirs report that a serious percentage of all hogs inspected is found to be tuberculous.

The aggregate of these losses among cattle and hogs is enormous, amounting to millions of dollars every year, besides materially decreasing the food supply of the country.

Turning to the other aspect of the case, the danger of infection of human beings with tuberculosis from cattle, we have only to consider a few facts to realize its vital importance to every community.

Milk is the staple food of infants and young children and is usually taken in the raw state. If this milk is from a tuberculous cow, it may contain millions of living tubercle germs. Young children fed on such milk often contract the disease, and it is a frequent cause of death among them.

Meat from tuberculous cattle is not so likely to convey the infection, for several reasons. It does not so frequently contain the germs, cooking destroys those that may be present, and, lastly, meat is not consumed by very young children.

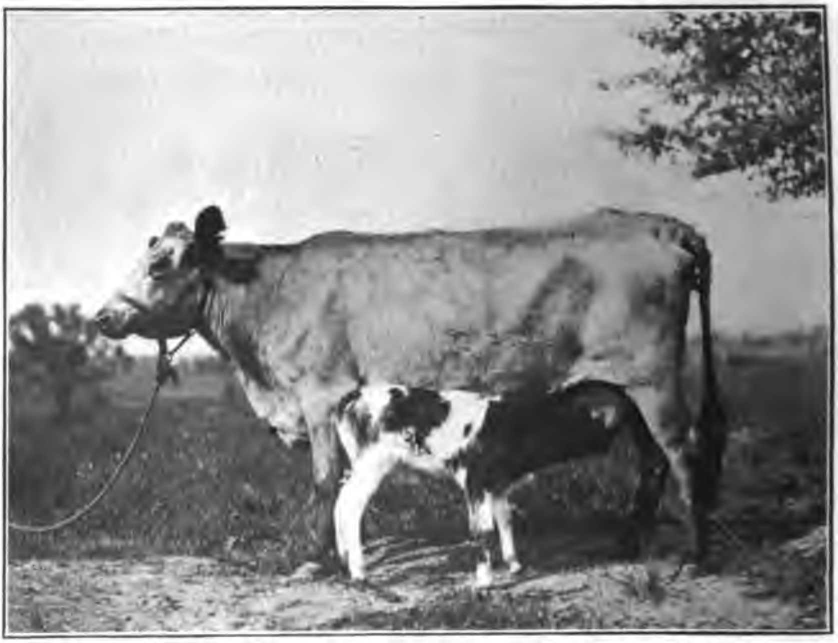

FIG. 3.—An apparently healthy cow affected with tuberculosis. She does not cough, her appetite is good, and her general condition is excellent for a milch cow that has recently calved. At the time the picture was taken it was known that she had been affected with tuberculosis at least four and one-half years and that she had been passing tuberculosis germs from her body for a long time. The calf by her side is the fourth she has produced in the last four years. Small quantities of her dung caused tuberculosis in guinea pigs when it was placed under their skin. The mixed dung of this cow and of the one shown in figure 2 caused tuberculosis in hogs that were permitted to eat it.

SYMPTOMS.

Before describing the symptoms or signs by which tuberculosis is recognized or suspected in a living animal it is well to state that there is no symptom that can be relied on with certainty. Any of the symptoms may sometimes be caused by some other disease, and not one of them is characteristic of tuberculosis alone.

Many of the symptoms that are relied on by the human physician in reaching his opinion are not available in examining cattle. The thickness of the skin and chest wall, for instance, makes it difficult to detect a diseased condition of their lungs by listening to the sounds made in breathing, whereas this is comparatively easy in human beings.

It must also be clearly remembered that cattle may be very badly diseased and yet show no symptoms of ill health. They may be fat and sleek, looking the picture of health, while their lungs and other organs are full of tubercles. Such cases can only be detected by the tuberculin test.

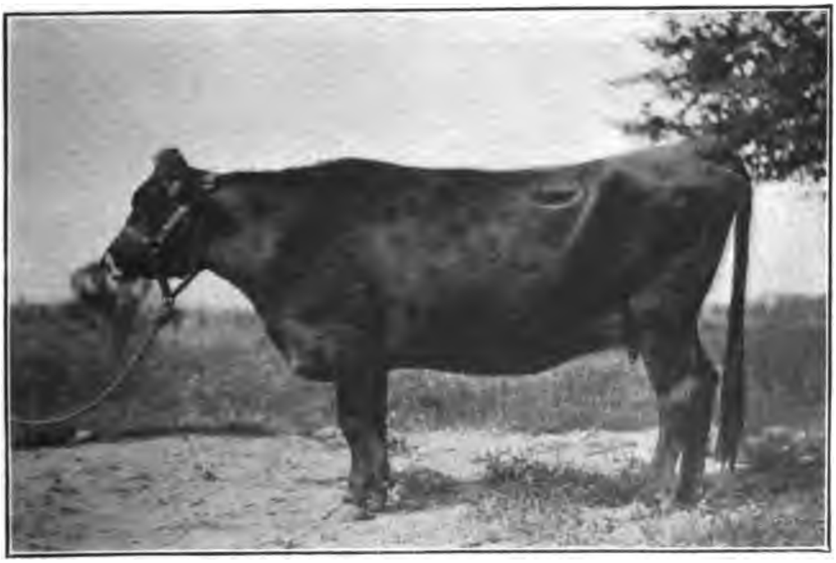

FIG. 4.—An apparently healthy cow affected with tuberculosis. This cow is in excellent condition for an animal that has been affected with tuberculosis more than four years. Three years before the picture was taken tuberculosis germs were found in her dung, and hogs that were permitted to eat it became tuberculous. About two and one-half years before the picture was taken it was found that her milk contained tuberculosis germs. There was nothing visible about the udder to show that it was diseased, and it was only after two months of the most careful tests of her milk that an expert could tell from which of the four quarters of the udder the disease germs were being passed.

As tuberculosis may attack almost any organ of the body, we may have in each case the symptoms connected with the part affected as well as those affecting the general state of the body as a whole. We will take up in detail each of the more important symptoms suggestive of the disease:

Unthriftiness.—The animal is not doing as well as it should for the care and feed it is getting. Its coat is rough and its skin has lost its suppleness and feels harsh and thick.

Loss of flesh.—Along with the unthriftiness is noticed a gradual loss of flesh; the animal gets thinner from week to week. It appears to be pining away, and such cows have been known to dairymen for a long time under the name of "piners" or "wasters." After a time they are reduced almost to skin and bone.

Cough.—This symptom is only present when the disease is attacking the lungs or some part of the breathing organs. It is not a loud, sonorous cough, but rather a subdued and infrequent one, and may be heard only at such times as when the stable is first opened in the morning or when the animal is driven. At a later stage of the disease it may be heard at any time of the day. Cows do not usually appear to cough up anything. This is because they do not spit. Most of the material coughed up from the lungs is swallowed, but many tuberculosis germs escape from the mouth in the form of spray or are discharged from the nose.

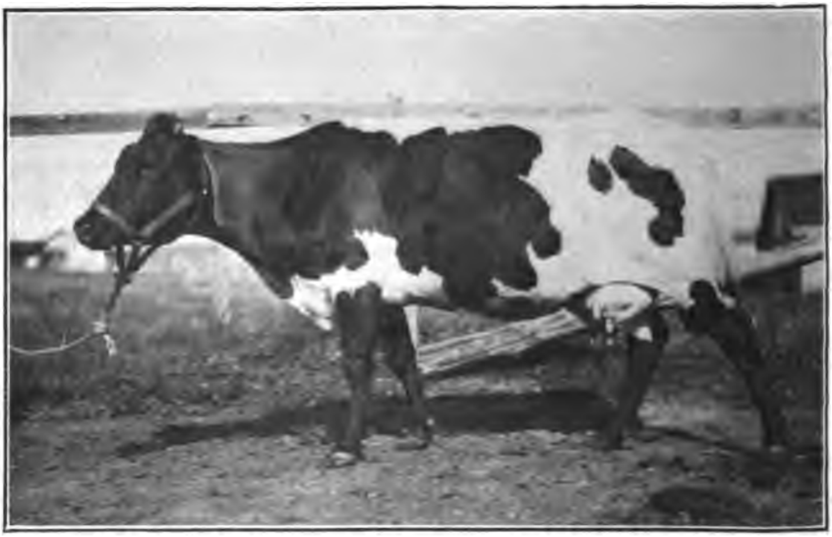

FIG. 5.—A cow affected with long-standing, advanced tuberculosis, with large tuberculous swellings in the udder. A year before the picture was taken the cow was discovered to have udder tuberculosis. This discovery was made by injecting some of her milk into guinea pigs; there was nothing in the appearance or external condition of the udder at first to show that it was diseased. How very dangerous such cows are may be judged from the fact that calves that are permitted to drink milk from tuberculous udders only a single time are almost certain to have tuberculosis. A small amount of milk from cows like those in the above picture and in figure 4 mixed with the milk of other cows will make the whole of it dangerous for both persons and lower animals.

Enlarged glands.—Enlargements in the region of the throat, especially when they cause difficulty in breathing, are very apt to be due to tuberculosis.

Loss of appetite.—This symptom is not seen until the later stages of the disease, when the animal is evidently wasting.

Bloating.—Sometimes the diseased glands in the chest prevent the usual passage of gas from the paunch to the mouth by pressing on the gullet. In this case the cow suffers from bloating, and the paunch is often greatly distended with gas. This, however, is not a very frequent symptom.

Diarrhea.—Looseness of the bowels or "scouring" is seen in cattle affected with the disease in the bowels. This kind of scouring can not be cured by any known treatment.

Hard lumps in the udder.—When tuberculosis attacks the udder no change can be detected at first, but after a time hard lumps can be felt in some parts of the organ after it is milked out. Milk from such an udder must not be used, as it is almost certain to be teeming with germs of the disease.

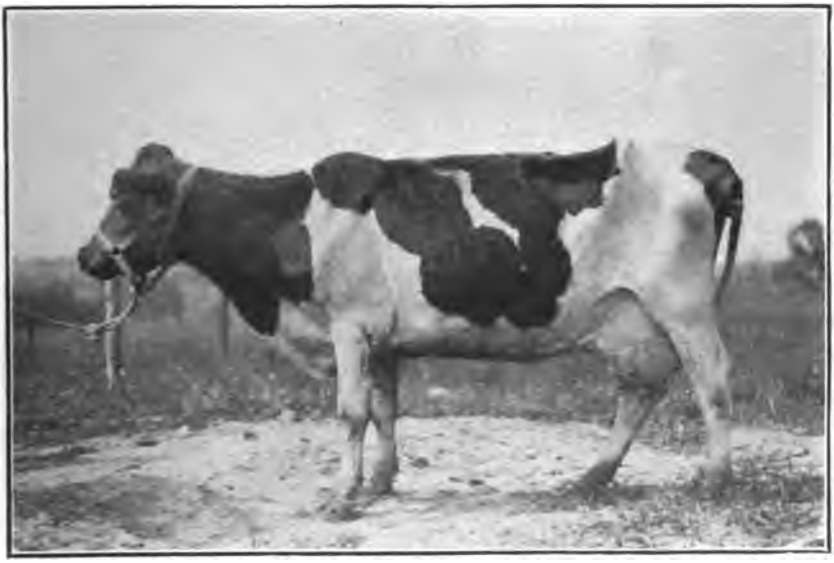

FIG. 6.—A cow in an advanced stage of tuberculosis. She is very weak and thin, but is a heavy milker and in her weak condition continues to give an abundant quantity of milk. Cows of this kind are unfortunately too numerous in dairy herds. The temptation to keep such cows and to use their milk is greater than some persons can resist. Such cows are a great danger to other animals that may come in contact with them, and the use of their milk in a raw state is very apt to cause tuberculosis alike in young persons and lower animals.

POST-MORTEM APPEARANCES.

When the carcass of a cow affected with tuberculosis is opened the disease may be found in any part of the body. Lumps (tubercles) may be present in the substance of an organ such as the lung or liver, or they may be growing on the surface. These lumps may be so small as to be scarcely noticeable, or they may be as large as the closed fist, or even larger. If one of the lumps is cut open, the inside is yellowish and grits on the knife like sand, or else is of a cheesy nature, soft and creamy, or hard and dry.

The lung is a favorite place for tubercles, and should always be examined. Lymph glands are often the seat of tuberculous changes. When healthy a lymph gland is a little rounded body not much larger than a good-sized bean, the largest only the size of one's thumb. They are found all through the body, and when healthy are so small as to attract very little attention. Tuberculosis may cause them to grow to an enormous size, sometimes as large as a child's head. In this condition they are similar to the tuberculous lumps already described. Those lying between the lungs and in the throat are the most frequently affected.

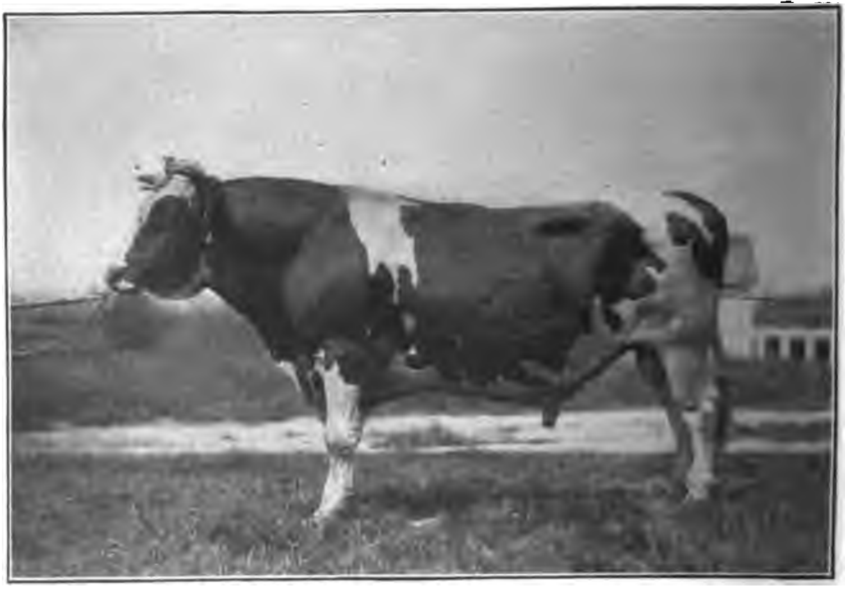

FIG. 7.—A tuberculous bull in apparently healthy condition. The picture was taken nearly four years after he was first known to be tuberculous and three years after it was known that he was passing tuberculosis germs from his body. Directly after his picture was taken he was killed, and in addition to numerous nodules of tuberculosis in his lungs it was found, when his body was opened, that nearly all the lymph glands connected with his bowels and liver were diseased. At the time of his death the bull weighed 1,850 pounds, and his apparent condition was excellent for an animal that was fed only rough forage and no grain in any form. The presence of tuberculosis in his body would never have been suspected before his death without the help of the tuberculin test.

Tubercles may be found in any part of the body—glands, lungs, liver, bowels, kidneys, womb, udder, and even bones. The muscles and skin are seldom affected.

THE TUBERCLE BACILLUS.

The germ of the disease, the tubercle bacillus, is a tiny, slender, rod-shaped body. Several thousands of them placed end to end would be needed to measure an inch, so that they are quite invisible to the naked eye. A powerful microscope is needed to see them.

Once the bacillus has gained lodgment inside the body of an animal, it begins to grow and multiply. It gets longer, and when full grown divides crosswise, making two out of one. Each of these goes through the same process, the two become four, the four eight, the eight sixteen, and so on indefinitely.

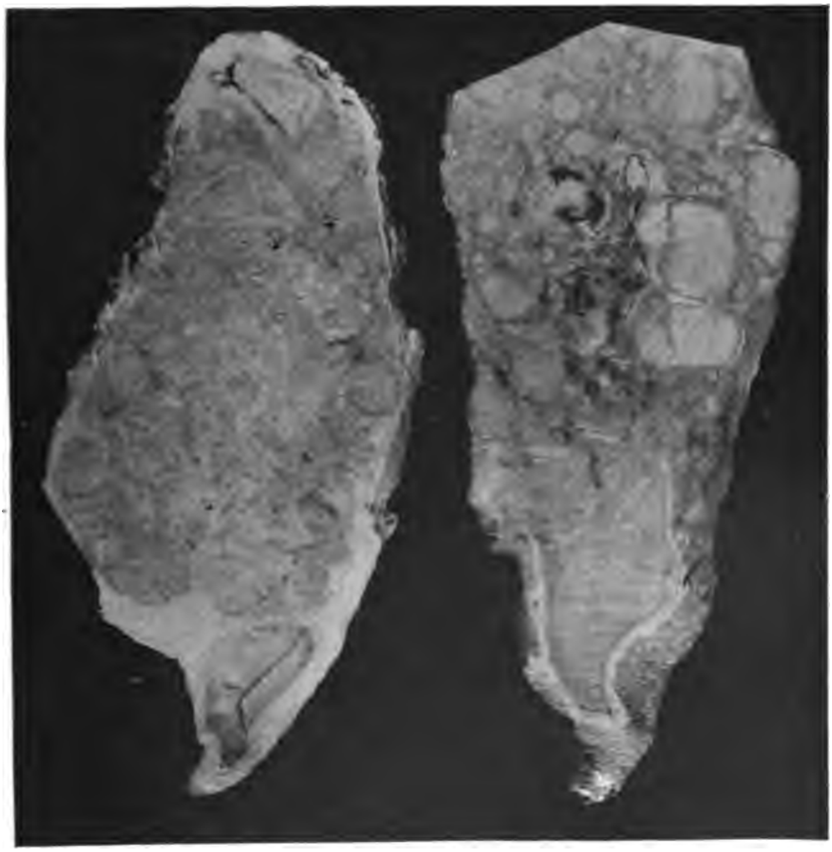

FIG. 8.—Sections of a tuberculous udder from a cow. Practically the whole of the udder was changed into tuberculous material. Long before tuberculous udders become as badly diseased as the condition shown in the picture the milk contains large numbers of tuberculosis germs and is very dangerous. A tuberculous udder may contain only a single small tuberculous swelling through which the milk becomes dangerously infected with tuberculosis germs.

This multiplication takes place quite rapidly when conditions are favorable, a few hours only being required for the birth of each generation. Nature, however, does not permit this process to continue long without offering some resistance. The forces of the body are roused to action and a battle begins between the tissues of the body and the army of the invaders.

The first line of defense is composed of the white cells of the blood, which hurry to the scene of action and endeavor to destroy the invaders by eating them up. Sometimes they are successful and the bacilli are destroyed, the infection checked. Often they fail in their object and are themselves destroyed and the multiplication of the germs continues.

The second line of defense is formed by the cells of the tissue invaded by the germs. These cells arrange themselves in a circle around the germs and try to form a living wall between them and the rest of the body. This barrier gradually becomes thicker and

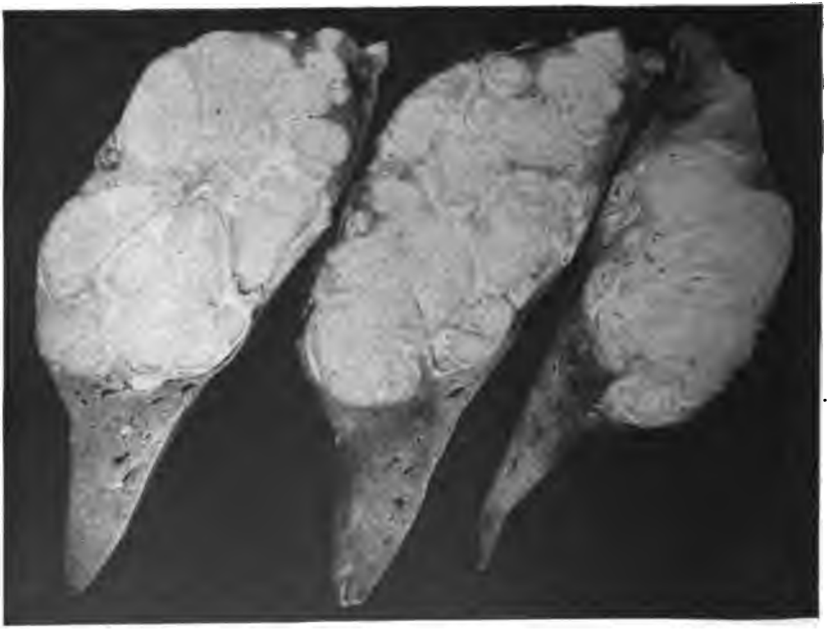

FIG. 9.—Sections of a tuberculous liver from a cow. The light-colored parts show the disease.

thicker and forms a little hard lump or tubercle, from which the disease gets its name. If this wall is complete and successfully imprisons the bacilli, these gradually die and the disease in that particular spot is arrested.

Frequently, however, both these safeguards are overcome. The germs break through the barriers and are carried in the blood stream or lymph channels to other parts of the body. New points of attack are selected and the process begins again but with less chance on the side of the animal. As the tubercles increase in number the power of the body to grapple with them becomes less and less, and gradually the animal falls a prey to the disease.

The tubercle bacillus does not multiply outside the body of an animal. It can live for a long time in favorable surroundings, such as dark and dirty stables. Sunlight soon destroys it. Freezing does not hurt it, but it can only stand a moderate amount of heat. Exposure of 149° F. for 20 minutes kills it. Protected by a layer of dried mucus, such as is coughed up from the lungs, it withstands drying, light, and ordinary disinfectants, but is readily killed by steam or boiling water.

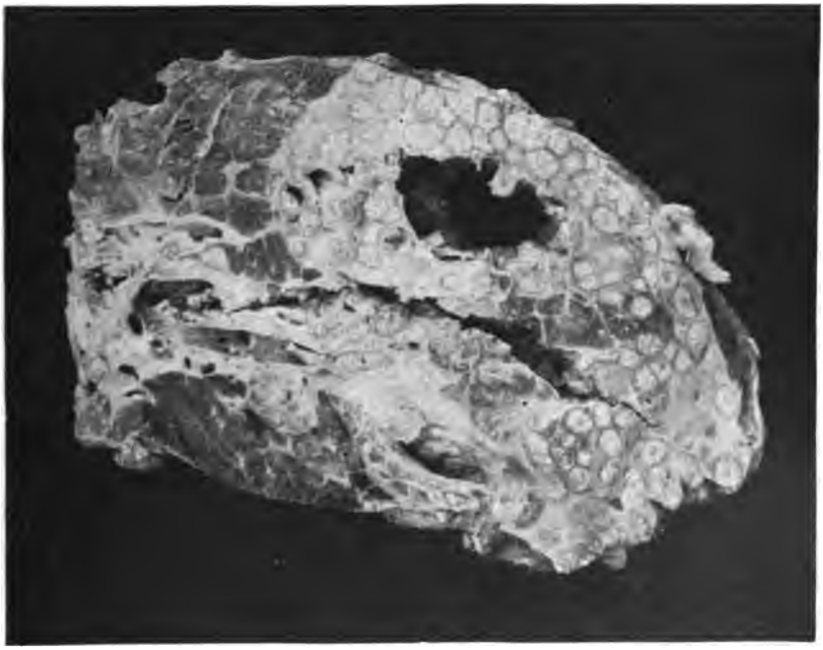

FIG. 10.—Section of a tuberculous lung from a cow. The picture shows numerous nearly round tuberculous nodules, one large tuberculous cavity, and several air tubes that extend from tuberculous nodules that are softening and breaking down. When tuberculous nodules in the lungs break down the material of which they are composed, and which contains millions of tuberculosis germs, is coughed up. Some of the germs are sprayed from the mouth and others are swallowed and discharged with the dung.

HOW THE DISEASE SPREADS.

Sooner or later the tuberculous cow begins to give off the germs of the disease. The germs escape by the mouth and nose, the bowels, in the milk, and in discharges from the genital organs. When the germs are being given off in any of these ways, the disease is known as *open* tuberculosis.

Germs discharged from the mouth and nose are coughed up from the lungs and are sprayed over the food in front of the cow or are carried in the air for a time until they fall to the ground. Cows in adjoining stalls may take in these germs in the air they breathe or in the food they eat and so contract the disease.

Germs discharged from the bowels are mixed with the manure, and may infect cattle and hogs that are allowed to pick over the dung heap. The practice of having hogs and cattle together in the same yard is sure to result in the infection of the hogs if any of the cattle are affected. The germs in the manure come from matter that is coughed up and swallowed, and in some cases from tuberculosis in the bowels themselves. Manure containing tubercle germs may easily infect the milk. Particles of dried manure may fall into the milk pail from the skin of a dirty cow or be accidentally flicked off from the tail and fall into the milk. Straining the milk afterwards only removes the larger particles. The smaller ones, including the germs, remain in the milk.

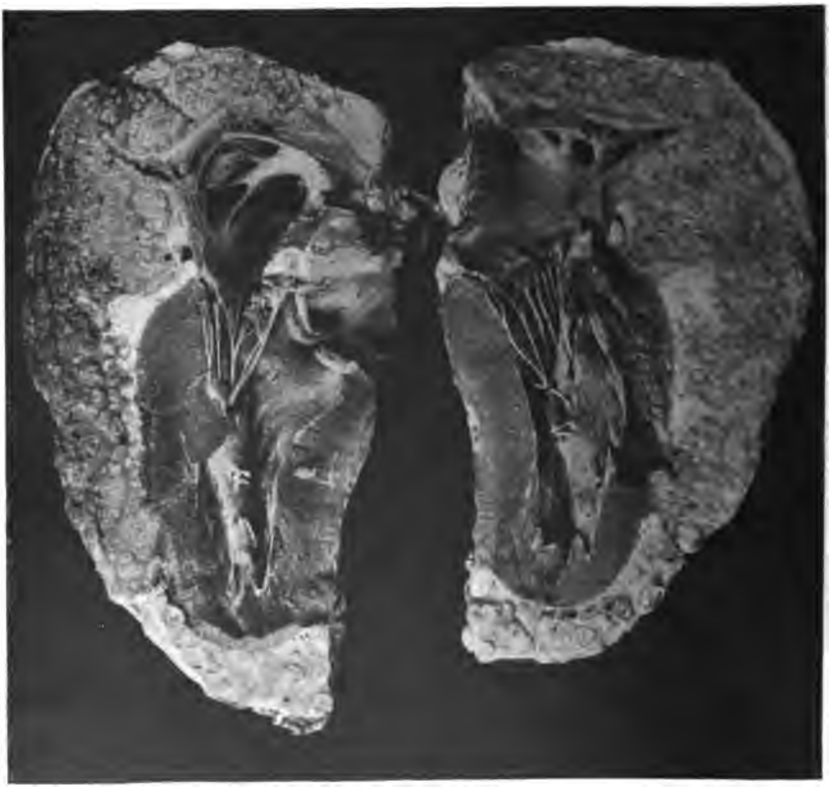

FIG. 11.—Sections of a tuberculous heart from a cow. The light parts are tuberculous. The heart muscle is greatly reduced in volume and is prevented from working properly by the tuberculous material by which it is surrounded. The picture shows how badly an animal may become diseased with tuberculosis before it dies. One reason why tuberculosis is so common among persons and cattle is that many persons and cattle pass tuberculosis germs from their bodies before anyone knows or suspects that they have tuberculosis and can give the disease to others.

When the udder is tuberculous the milk contains the germs in vast numbers. Such milk may look and taste perfectly good, but readily transmits the disease to young animals. It is very dangerous to children. Hogs and calves are very readily infected by it.

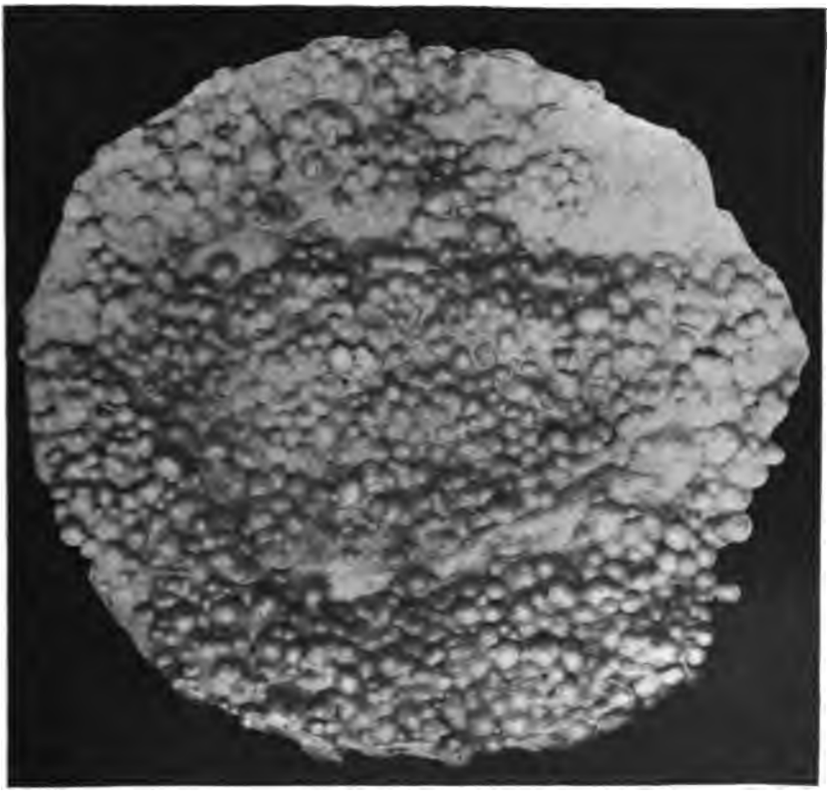

FIG. 12.—Tuberculosis of the omentum or caul, or the net covering the bowels. This form of tuberculosis is known as "pearl disease," because the tuberculous tumors look like pearls.

HOW A HERD IS INFECTED.

Tuberculosis may be introduced into a healthy herd in a number of ways:

1. By the purchase of a bull or other animal that is infected with the disease. This animal may be apparently healthy at the time of purchase, but if it contains the germs, the disease may develop and spread to other cattle. New animals should only be bought from a herd that is known to be healthy.

2. By feeding calves with milk, buttermilk, or whey that has come from tuberculous cows. A farmer may have a healthy herd, but if he brings home skim milk from a creamery and feeds it to his calves

he may give them the disease. Such milk should be rendered safe by boiling or pasteurizing it.

3. By showing cattle at fairs and exhibitions where no proper care is taken to keep out diseased stock or to disinfect the stables.

4. By shipping animals in cars that have not been disinfected, as these may have recently carried diseased cattle.

5. By allowing cattle to graze with diseased ones, or to come in contact with them over fences.

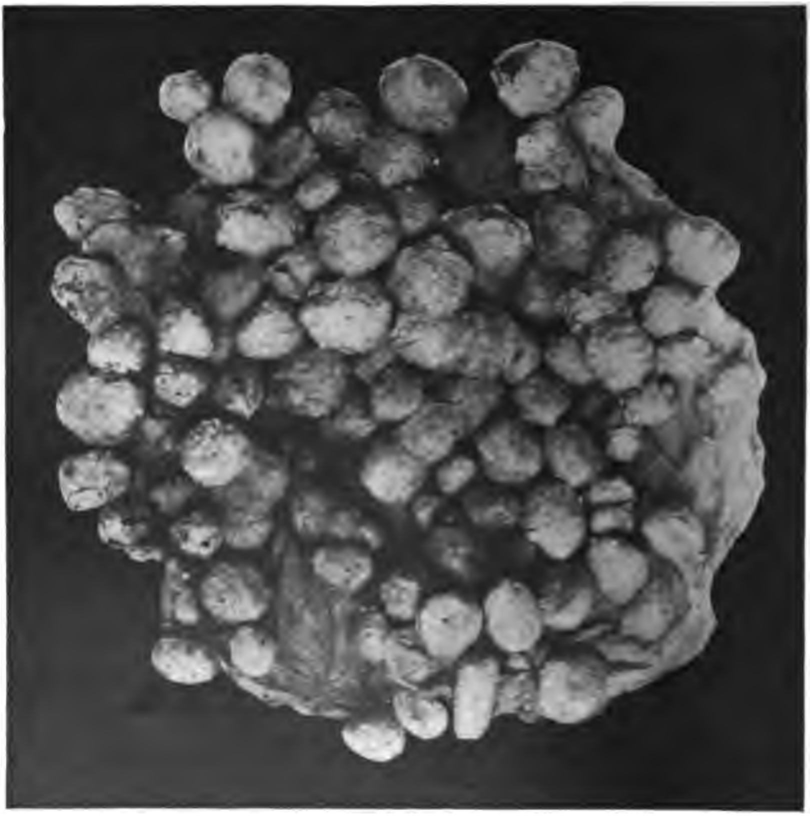

FIG. 13.—Tuberculosis of the omentum or caul. The picture shows another form of "pearl disease," in which each nodule is about the size of a grape and is composed of a large number of smaller nodules which have grown together.

THE TUBERCULIN TEST.

Tuberculosis develops so slowly that in many cases it is months and sometimes years before any symptoms are shown. During this period the infected animals can not be distinguished from the healthy in any ordinary way. There is a test, however, which does no harm to the healthy yet detects the diseased practically without fail. This is known as the tuberculin test, because the substance used in making it is called tuberculin.

WHAT IS TUBERCULIN?

Tuberculin is a fluid containing the products of the tubercle germ without the germs themselves. As it contains no living germs, it can not convey the disease. Great skill is required in its preparation. A special fluid (or culture medium) is prepared and the tubercle bacilli planted in it, great care being taken to keep all other germs out. The fluid is then placed in a special kind of incubator and kept at the temperature of the animal body. Under these conditions the germs grow and multiply. Gradually the fluid becomes filled with the products of the germs. When the right point is reached the fluid is heated sufficiently to kill the germs, which are then strained out. The remaining fluid is tuberculin.

Tuberculin does not harm healthy cattle, even in large doses, but on diseased animals it produces a marked effect. This is shown by a feverish attack which comes on about 8 to 12 hours after the tuberculin is administered, lasts a few hours, and then subsides. This temporary fever is called the reaction, and animals which show it are called reactors. The value of the test lies in the fact that diseased animals react, while healthy ones do not.

RELIABILITY OF THE TEST.

The tuberculin test in the hands of a competent and experienced man is much more accurate than any other method of detecting tuberculosis. The records of large numbers of tests made by Government officials show that with certain precautions it is accurate in 98 per cent of the reactions obtained. This gives a margin of a possible 2 per cent of error, and this small number may be still further lessened by care in making the test. For practical purposes any animal that reacts must be considered tuberculous.

LIMITATIONS OF THE TEST.

The test should not be applied to cows that have just calved or are about to calve, as the temperature at this time is apt to vary considerably from the normal. For this same reason it should not be applied to any animal that is in a feverish condition from any cause.

The test fails to detect the presence of the disease in the animal that is very recently infected. The disease has to make a little progress before the test reveals its presence, and in the beginning of each case there is a period between the entrance of the germs into the body and the time when they have multiplied sufficiently for the test to reveal their presence. This is called the period of incubation and lasts from ten days to two months.

When the disease is far advanced and the animal is wasting, the test sometimes fails to detect it. This is not of much practical importance, as such cases can generally be recognized without the aid of tuberculin.

PROTECTIVE INOCULATION.

For some years efforts have been made to discover a method of rendering cattle immune to the disease in such a way as men are protected from smallpox by vaccination. Up to the present these efforts have been only partially successful, and until the methods in use have been perfected by further investigations they can not be recommended as of practical use in the suppression of the disease.

SUPPRESSION OF THE DISEASE.

The first step in getting rid of the disease is to find out how many of the herd are affected by it. This is done by applying the tuberculin test. This will show a larger or smaller number of the herd to be affected, and the proper course to pursue will depend largely upon the proportion of the reactors in it.

Suppose that only a few cattle react, say 15 out of 100, or in that proportion. In this case the reactors are first carefully examined, and if any of them show symptoms of the disease by coughing, loss of condition, or any other of the signs by which the disease is recognized without the test, such animals should be slaughtered.

The other reactors should then be entirely separated from the healthy cattle. If possible they should be put in a separate building, but if this can not be done a tight partition should be built between the diseased and the healthy cattle and separate ventilation provided. The person who attends to the reactors should not go near the healthy animals, as he may carry the infection to them on his hands, clothes, or boots. For the same reason the feeding and watering must be done with separate utensils.

When at pasture the reactors must not be put into a field where they can reach across a fence to healthy cattle. Whenever a calf is born among the reactors it should be immediately separated from its mother and brought up by hand or on a healthy cow. The calf is usually born healthy, but would soon catch the disease from its mother if allowed to remain with her.

The milk of reacting cows may be used if it is first boiled or heated to a point sufficient to kill the germs. This heating to a point less than boiling is called *pasteurizing*, and is safe provided all the milk reaches the required degree of heat and is kept there sufficiently long.

For this it is necessary to keep the milk for 20 minutes at 149° F. or for 5 minutes at 176° F.

This system of dealing with tuberculosis in a herd was planned by Prof. Bang, of Denmark, and has been very successfully followed in that country for some years. It has the advantage of allowing the reactors to be made use of while a sound herd is being built up. Under this system the sound herd increases in numbers as healthy calves are added to it, while the diseased herd becomes smaller as the reactors die off or are killed as open cases of tuberculosis. Finally a point is reached where only a very few reactors remain, and the owner will then find it to his interest to kill them rather than have the trouble of keeping them isolated.

Some time is required for the successful carrying out of the Bang system, and the owner must be prepared to follow it steadily and faithfully for the whole time that is needed, which may be several years. During this time the healthy herd must be tested every six months and any reactors removed to the diseased herd. At the same time a sharp lookout must be kept for animals showing definite symptoms of the disease. These should be destroyed promptly, as they are the most dangerous source of infection.

Dealing with a badly infected herd.—Where the test shows more than half the number diseased, a somewhat different plan is required than the Bang system. This herd is so badly affected that the non-reactors can not safely be considered healthy. Many of them are sure to have been infected with the disease quite recently, so that the test fails to detect it. These will react at the next test, and in the meantime may develop the disease so rapidly as to infect others. This will repeat the difficulty occurring at the first test, and it would be a long and tedious process of weeding before even a small but perfectly healthy herd could be established.

For these reasons it is better to treat such a herd as if it were entirely diseased and to begin with the newborn calves to build up a healthy herd. The method from this point is exactly the same as the Bang system, except that as there are no healthy cows to act as foster mothers the calves must be raised on pasteurized milk. At 6 months old the calves are tested and reactors are transferred to the other herd. This plan was devised by a German veterinary surgeon named Ostertag, and is known as the Ostertag system. It is very successful when carefully carried out.

While getting rid of the disease by whatever system may be adopted, an animal should never be bought for the healthy herd unless known to be healthy. The tuberculin test should be applied, and if possible the animal should be selected from a herd that is known to be free from tuberculosis. New purchases should be isolated or kept apart from the healthy herd, and if possible from each other for at least three months, when they should be retested to make sure they are healthy before putting them with other cattle.

SANITATION.

Dark, dirty, crowded stables are favorable to tuberculosis. Under these conditions the disease spreads rapidly and is only kept out with difficulty.

Clean, airy, well-lighted stables, on the other hand, are unfavorable to the development of the disease. If brought into such a stable it does not spread so rapidly and is not so difficult to get rid of as in the first case.

A well-built, sanitary stable need not be made of expensive material or of elaborate design, but should have plenty of light, air, and drainage.

Light is very important. Direct sunlight is a great destroyer of germ life. Tubercle bacilli soon die if exposed to sunlight. It is a disinfectant, always ready to work without cost. Sunlight is also necessary to the health of animals. Men deprived of it for any length of time, as prisoners in jail, become pale and lose the appearance of health. Cattle that are constantly confined in dark stables become lowered in vitality and are ready to catch any disease with which they come in contact. For these reasons the cow stables should have plenty of windows, on two or more sides, if possible, so that the sunlight can reach every part of the interior some part of the day.

Pure air is also very important. In badly ventilated stables the air is breathed over and over again until it becomes more or less poisonous. Animals kept in such conditions become gradually reduced in vitality. This change may not be noticeable to the observer, but becomes apparent if the animal is exposed to disease. It easily contracts disease and does not recover from it readily.

Stables should therefore have plenty of air space for each animal. This requires the ceiling to be high, the stalls roomy, and the passages wide. In addition to this ample air space some way of changing the air in a stable must be provided. This is done by means of suitable openings in the walls and roof and comprises the system of ventilation.

Ventilation to be successful must provide for two things—first, the removal of the foul air from the inside, and, second, the bringing in of fresh air from outside the building. No system is good that fails to accomplish these objects without causing unnecessary drafts.

The usual way is to bring in fresh air through open windows, and in cold weather through ventilating shafts, which may be concealed in the walls or beneath the floor. The foul air is removed by open windows and by ventilating shafts from the ceiling to the roof, where they are usually protected by a hood. When both inlets and outlets are proportioned to the size of the building there should be a constant circulation of air and no sensation of closeness should be perceptible in the stable.

Drainage removes the liquid refuse from the stable by suitable gutters and drains. It can not do this unless the floor is water-tight, and concrete flooring is therefore recommended. Urine leaking through cracks in the floor until the soil beneath is saturated is a frequent source of foul odors and unhealthy stables.

Cleanliness.—Since the manure of tuberculous cattle often contains living tubercle germs in vast numbers, the importance of keeping it well cleaned out of the stable is readily seen. Such manure is not only dangerous to other cattle in the stable, but may be the means of conveying the disease to children. Often cows are seen with their flanks incrusted with dry dung. Parts often break off while the cow is milked, and some of it is likely to fall into the milk pail. The larger lumps are strained out, but the smaller particles remain, and also the tubercle germs, which are small enough to pass through any strainer. These stay in the milk and make it a fruitful cause of the disease in the young.

Stables should be cleaned out often and the manure put where it can not be picked over by hogs or cattle. These animals are easily infected in that way. Cleanliness also includes keeping the walls and ceilings free from dirt, dust, and cobwebs. These are all good resting places for disease germs.

Whitewashing the interior of the stable at least twice a year is a great aid to cleanliness, and also has a distinct effect in destroying disease germs. In many municipalities dairy stables are required to be whitewashed at regular intervals, and it is a practice that should be universal.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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Issued November 29, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN NO. 474.

THE USE OF PAINT ON THE FARM.

BY

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Bureau of Chemistry.

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1911.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., September 20, 1911.

SIR: I submit for your approval a manuscript prepared by Mr. P. H. Walker, chief of the contracts laboratory of this bureau, on the use of paint on the farm, which it is thought may serve a useful purpose by calling attention to the economic importance of painting farm buildings and equipment, and giving such nontechnical directions and discussion as may serve to assist the farmer in the purchase and use of painting materials. The composition of paints can not be discussed to any extent without involving much technical detail, nor is it thought that the farmer can often mix his own paints to any great advantage; for these reasons no attempt has been made to give many formulas. The information given will, it is thought, enable him to purchase the paints economically and apply them intelligently and to the best advantage.

Respectfully,
F. L. DUNLAP,
Acting Chief, Bureau of Chemistry.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE USE OF PAINT ON THE FARM.

INTRODUCTION.

There is probably no one point more neglected by the average farmer than the judicious use of paint, not only on his house and outbuildings, but also on machinery and various agricultural implements. It is perhaps the rule rather than the exception in some sections to see houses and agricultural implements on the farm sadly in need of paint. The idea seems to be prevalent that paint is used solely for ornamental purposes, and its use is regarded as a luxury rather than a necessity. While paint does, of course, serve the purpose of improving the appearance of property, it is far more useful for protection than for ornament. A small amount of money and work expended in keeping a valuable piece of machinery properly painted will add greatly to the length of its life. The same may be said of buildings. Another useful object which is accomplished by painting is the improved sanitary conditions of buildings and outhouses. It is not proposed in this bulletin to give instructions for artistic painting, or even for doing the class of work which would be expected of a first-class master painter, for such work can not be expected of one engaged in another business. But any man can do an average job of painting, and can thereby not only improve the appearance of his place, but can add greatly to the durability of all articles painted. The cost of such work is small, the necessary equipment is not expensive, and with proper care will last a long time. An attempt will be made to give directions for the care of paint and of the necessary tools used in its application and for the proper selection of different paints for various purposes, their preparation and application, and their approximate cost.

Certain terms will be used frequently with a somewhat restricted meaning, and they are therefore defined as follows:

A paint is a mixture of a pigment with a vehicle and is intended to be spread in thin coats for protection or decoration or both.

A pigment is the fine, solid material used in the preparation of paint and is substantially insoluble in the vehicle.

The vehicle is the liquid portion of the paint.

Bearing in mind these definitions, it is seen that while varnish is used very much in the same manner as paint, it could not be properly classified as a paint, because it does not contain any solid particles of pigment. On the other hand, whitewash, which is not ordinarily called a paint (largely because of its cheapness), would comply with this definition very well.

BRUSHES AND OTHER IMPLEMENTS.

The only absolutely necessary implements are brushes. Probably the most generally useful brush is a round one with bristles about 6 inches long. Oval brushes from 2 to 2½ inches wide are also very good for general use, and a great deal of painting is done with 4 or 5 inch flat brushes. Of these three types it is difficult to say which is the best, different painters having their own individual preferences. The advantage of a flat brush is that a greater amount of surface is covered at a stroke, with the disadvantage that the paint can not be as thoroughly rubbed in. On the whole, therefore, it is best to use a round brush. The 6-inch bristles are too long for proper working, and before being used a piece of cloth should be tied around the brush about 4 inches from the end of the bristles and 2 inches from the binding. As the bristles are worn off this sleeve or bridle, as it is called, may be pushed back, thus materially lengthening the life of the brush. For painting sashes and other small surfaces smaller brushes are necessary, the most satisfactory being the small oval brushes with a chiseled end. For varnishing, oval or flat brushes with somewhat shorter bristles are generally used. For the application of whitewash and calcimine a very much larger brush may be used, since these are applied lightly to the surface and are not rubbed in. A flat 8 or 9 inch whitewash brush may be used with practically as much ease as a smaller one.

In addition to the paint brushes, dusting brushes made of stiff bristles are useful for cleaning the surface before painting. For cleaning rusted metal surfaces, steel-wire brushes (2 or 3 inches wide and 6 inches long with wires about 3 inches long) are frequently necessary.

If ready-mixed paints are bought the cans may serve as buckets, but if the paint is mixed from the paste a strong tin bucket large enough to allow for stirring the paint will be necessary. Scraping knives and putty knives are necessary tools for the painter, and it is well to have one or two of each, but a very good scraper can be improvised from a piece of sheet iron, and an old kitchen knife may be ground to a square end and converted into a very serviceable putty knife. A paint strainer is useful, but two thicknesses of cheesecloth tied over the top of a bucket answers practically as well. Paint should be strained before using it.

CARE OF BRUSHES.

Brushes for applying oil paints must be well cleaned after using, though for keeping overnight it is generally sufficient to wrap them in several thicknesses of paper. Some painters keep their brushes overnight by putting them in water. If, however, the brush is not to be used for several days, the paint should be washed out of it. Turpentine is one of the most satisfactory materials for washing a brush, but it is expensive, and a brush can generally be washed as well with kerosene, which is much cheaper. After washing off the paint with kerosene the brush should be rinsed with gasoline or benzin, then thoroughly shaken and well washed with soap and warm water. As soon as this washing is complete the brush should be shaken thoroughly so as to throw as much water out of it as possible and hung up with the bristles down to dry; when dried the brush should be thoroughly protected from dust. If much painting is being done it is less trouble to keep the brushes in turpentine or kerosene. For this purpose hooks should be fastened on the inside of a pail with a close-fitting cover, the brushes being suspended either by holes in the handles or by loops of string, so that the brushes hang in the kerosene or turpentine in the bottom of the pail. The bristles should be submerged in the liquid, but should not touch the bottom of the pail. If kerosene is used for cleansing, it should be removed by shaking the brush and rinsing it in turpentine before using again with paint. Brushes used with whitewash or calcimine should simply be washed and not put in the same liquids in which the brushes used for oil paints are kept. If a brush has been used for shellac varnish it should be kept in alcohol or in the varnish itself. In general a varnish brush may be kept in the varnish in which it is used.

DRYING OF PAINTS.

Water paints such as whitewash and calcimine dry in the ordinary sense; that is, by evaporation of the liquid, which in the case of the two paints mentioned is water. The drying of oil paints, however, is quite different, and in order to understand this attention must be drawn to certain peculiarities of the so-called drying oils. Suppose four plates of glass are coated, one with a thin film of water, another with gasoline, another with a heavy mineral oil, and another with linseed oil, and all four plates are exposed to the air for several days. The water and gasoline will evaporate and leave the plates dry and practically in the condition in which they were before applying the liquid. The plate covered with the heavy mineral oil will be found to be greasy, while the plate covered with linseed oil will also have a coating on it, but this coat will first become tacky and finally set to a hard, varnish-like film. If this experiment is tried with other vegetable oils, such as olive oil, it will be found that some of them behave very much like the mineral oils; that is, there is very slight tendency toward the formation of a coating. Other oils, such as corn and soy bean, will behave in a manner similar to the linseed oil; that is, there will be the formation of a more or less tacky mass, with perhaps the final formation of a varnish-like material. None of the other common oils, however, will form the varnish-like coating so rapidly, nor will the coating be so hard as in the case of linseed oil.

Oils which behave like linseed oil are called drying oils. It will be seen from this illustration, however, that the term "drying" as applied to oil is not similar to the drying which takes place on the exposure of a material wet with water to the dry air. The drying of a substance wet with water is really the removal of the water by evaporation. The drying of a drying oil is a change taking place in the liquid. This change is accompanied by an absorption of oxygen from the air, and the drying does not take place in the absence of oxygen. It is hindered by moisture and hastened by sunlight.

The formation of this varnish-like film by the so-called drying of linseed oil is an exceedingly important operation in the drying of oil paints. Certain substances, compounds of lead and manganese, if dissolved in the oil, hasten drying. Boiled oil which contains compounds of lead or manganese, or both, will dry more rapidly than raw linseed oil. Instead of using boiled oil, however, the drying of the oil in paints is generally hastened by the addition of liquids known as driers. These liquids are composed of compounds of lead and manganese generally thinned with either turpentine or benzin, and are known as japan or japan driers. As before stated, while the use of a drier is necessary in a great many paints, the amount used should be small. It is a rather astonishing fact that many driers, if used in small proportions, will very materially hasten the drying of the linseed oil; whereas if a large amount of drier is added, the drying of the oil is retarded. There is another objection to the use of a large amount of drier, and that is that the film produced is not so durable as one produced by raw linseed oil alone or by the use of a raw oil containing the proper amount of drier. There are a number of other oils which have the property of drying like linseed oil, but none of them is the equal of linseed oil for a paint vehicle.

Bearing in mind these facts, it is seen that an oil paint would consist of the pigment mixed with a drying oil, preferably linseed oil, and generally with the addition of a drier. Some pigments, however, have the property of hastening the drying of linseed oil, and when they are used (red lead, for example) it is unnecessary to add any other drier. The varnish-like film left by linseed oil is for practical purposes insoluble in water. It is not, however, impervious to water. If a bright piece of iron covered with a coating of linseed oil, and afterwards thoroughly dried, is exposed to moisture it will be found that while the iron will not rust so fast as uncoated iron, the rusting will take place to a considerable extent. Other experiments can be performed which will demonstrate that moisture passes through this film with comparative ease. But, if an oil paint is employed—that is, a mixture of pigment and linseed oil—it will be found that the water does not penetrate through the film so rapidly as it does through the linseed-oil film alone. Also the paint film is more resistant to mechanical abrasion. While there is some difference of opinion among experts as to the amount of pigment which should be used in a paint, it is generally considered that the greater the amount of pigment the more resistant the paint film is, provided all the particles of pigment are thoroughly covered with the oil. It would appear, therefore, that a film of oil, while it may seem to be homogeneous even if examined under a high-power microscope, is really porous, and by mixture of the oil with the pigment the pores are more or less completely filled, thus making a more impervious film.

In addition to the linseed oil and drier, paints frequently contain volatile substances, such as turpentine and benzin. The addition of these is largely for the purpose of thinning the paint to a better working consistency, so that it can be spread in thin layers more easily. These volatile substances evaporate almost completely and do not remain behind in the dried film. The only substance remaining which binds the solid particles of the pigment together is the oil.

PREPARATION OF SURFACES FOR PAINTING.

All surfaces should be clean and as dry as possible before the application of an oil paint. Much new wood is very difficult to paint. The resins in such woods as yellow pine and spruce tend to destroy any paint that is laid over them. When possible, it is well to allow a new house to stand unpainted for at least six months or even a year after the woodwork has been completed. By this exposure to the weather the resins are brought to the surface and are either washed away or hardened, and the resulting wood surface is in much better condition for painting than is a new structure. An unpainted house, however, is an unsightly object, and it is often desired to paint a new house at once. Painters adopt several methods of treating new wood; probably the one most universally used is to coat all knots and other places where resin appears with shellac varnish, a solution of gum shellac in alcohol. Another plan is to mix with the priming coat of paint a small amount of benzol (coal-tar naphtha), which is claimed by some excellent authorities on painting to dissolve the surface layer of resins and allow the paint pigment to penetrate into the fibers of the wood, preventing the final forcing of the resins to the surface. After applying the priming coat, all nail holes and cracks should be well filled with putty pressed in hard. Filling in with putty should not be attempted before the priming coat is applied, as it is not likely to stick as well.

In painting iron surfaces all rust and grease should be carefully removed, scraping the surface down to bright metal with wire brushes or sandpaper and finally dusting off all adhering particles.

Painting should be done in warm, dry weather. It is much better to select the summer time for painting than the winter. Not only does the paint not flow so well in cold weather, but the surfaces of the painted objects are more likely to be moist, and a little moisture underneath the paint film, either on wood or iron, is very apt to cause serious trouble.

PAINTING EXTERIOR WOODWORK.

All wood is more or less porous, and the natural result of applying a substance like paint to such a material is that the liquid portion sinks into the wood and leaves a large portion of the solid material on the surface. Also different parts of the wood will differ in porosity, and there will tend to be different amounts of paint left on different portions of the surface. In order to do a good job of painting it is practically always necessary to apply several coats to new wood. The first or priming coat is made thinner than the others, the amount of thinning depending upon the porosity of the wood. For ordinary pine, a paint of proper spreading consistency, when mixed with an equal volume of raw linseed oil, generally furnishes a good material for priming. With very porous wood, such as redwood, more oil may be added. The priming coat should be applied with as much care as any other and should be thoroughly brushed into the wood, the brushing being carefully done so that the paint is evenly distributed, with no tendency to run. It is the custom of many painters to add a great deal of drier and of turpentine to the priming coat, and to apply the other coats almost immediately after finishing the priming. This is not good practice. The paint for priming should consist of the pigment, linseed oil, and a minimum amount of drier, with no turpentine or benzin; and after applying it at least a week and preferably longer should elapse before putting on the second coat.

Three coats at least are generally necessary to make a good piece of work. The effect of the priming coat, if properly applied, is to fill the pores of the wood and furnish a foundation on which to apply the subsequent coats. Owing to the different porosity of different parts of the surface, it is almost impossible to completely fill with one priming coat, and an attempt to get a good effect by applying the finishing coat immediately on top of the priming generally results in failure. A second coat will not penetrate to any very great extent into the wood. It should not, however, dry with a gloss, because a glossy surface does not furnish a good foundation for the next coat. In order to prevent the gloss, most painters add turpentine to the paint for the second coat; the amount used, however, should be small—to each gallon of paint about a half pint of turpentine in hot weather, or a pint in cold weather, is sufficient. The second coat, which of course should have been evenly spread and well rubbed in with the brush, should be allowed to dry somewhat longer than the priming coat. The third, or finishing coat should be one which will dry with a gloss, and for this purpose there should be no turpentine or thinner added to the paint at all. This method is one which is advocated by a large majority of authorities on the painting of wood, but is seldom carried out by painters, the tendency being to add excessive amounts of turpentine or benzin, unduly thinning the paint and making it possible to spread it in thin, even coats with less labor than would be required for the same thinness and evenness when paint of a proper consistency is used.

INTERIOR PAINTING.

For oil painting exposed to the weather (outside painting) it is very important that a durable paint be selected, because even the best painted surfaces in time are destroyed by outdoor exposure. Inside of a house, however, the conditions are radically different. The painted surface is exposed to neither the extreme heat of the summer sun nor to the action of rain and frost to anything like the extent that outdoor painting is. In fact, any paint will last for a very long time inside. The main point in selecting a paint for this work is to choose one which will cover well the article to be painted and which contains colors that are permanent. The actual protective coating may be assumed to last as long as there is any necessity for it. Very light tints or very brilliant colors are likely to fade, and white paints containing a large amount of oil tend to turn yellow in dark rooms. The pigment lithopone, which is not suitable for outside work, can be used with satisfaction for interior painting. Calcimines, the so-called cold-water paints,[1] in which no oil or expensive lead or zinc pigments are used, and which are, therefore, very much cheaper than oil paints, last very well on the inside; in fact, some of the oldest paintings in existence are fresco paintings made practically of calcimine.

For interior work the same directions apply as to outside painting, but it is not so important to have the final coating contain such a large amount of oil as to give a glossy finish. A dull finish is preferred by many people, and since this paint is not to be exposed to severe weather conditions, a larger amount of thinner may be used than for outside work. Also, paint for inside work should dry faster than one for the outside, and a somewhat larger amount of japan drier is generally used.

PAINTING OF METAL.

Tin or other metal roofing, also galvanized iron such as gutters and rain spouts, are very difficult to paint, as often the paint does not stick well. This is probably due to a very thin film of grease left on such material from the process of manufacture, and before attempting to paint a tin roof it is best to scrub it perfectly clean with soap and water or with cloths moistened with benzin, and then thoroughly dry before applying the paint. Galvanized iron may be treated in the same way, but it is much better to let this material stand for some time exposed to the weather before painting. The metal portions of machinery are generally cast iron or steel; wrought iron is rarely used, though it is more durable than steel. Cast iron is not so liable to rust as steel, and also the pieces are frequently thicker than the steel portions of a machine. There is perhaps nothing that actually needs paint for protection as much as the steel and iron portions of machinery. Before painting such material the greatest care should be taken to get the surface perfectly clean. Do not apply paint over rust, but clean thoroughly down to the bare metal with scrapers or wire brushes, and finally with dry scrubbing brushes. It is a mistake to spare labor in preparing a metal surface for paint. All oil and grease should be scrupulously removed, and the metal surface should be absolutely clean and dry before painting. The paint should be well brushed on, carefully filling all cracks.

Two or three coats of any good paint may be used. The paint which is generally supposed to protect iron from rusting better than any other is red lead. This is expensive, however, and rather hard to apply. The color also is some objection, although this can be overcome by mixing some dark pigment with it. The addition of a small amount of lampblack improves the color and the working quality of red-lead paint. A paint made of basic chromate of lead

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[1] See page 21 for recipes for making calcimine.

(so-called scarlet lead chromate, or American vermilion) is even better than red lead as a material for protecting iron. This also is very expensive, even more so than red lead, and while the protection is not so complete with the use of cheaper paints made of iron oxid pigments, on account of the fact that pieces of machinery are very likely to have the paint scratched and injured mechanically, it is perhaps best to use an iron oxid paint for most of such work, because of its cheapness. Any good oil paint will give valuable protection to iron if it is properly applied.

MIXING PAINTS.

Paints may be prepared either by mixing the dry pigments with oil and turpentine or benzin; or the paste pigments may be used. The latter are ground in a small amount of vehicle, generally linseed oil. The best pigments are exceedingly fine powders, and it is frequently a matter of considerable difficulty to mix such a powder uniformly with oil so as to have every particle in contact with the vehicle. On this account it is generally considered much easier to make up a paint from the paste pigments than from the dry, because the former have already been ground in a small amount of oil in a mill. When a can of paste pigment is opened all of it should be used immediately or it should be mixed with some oil and kept covered, since the paste is likely to harden and will then be ruined if exposed.

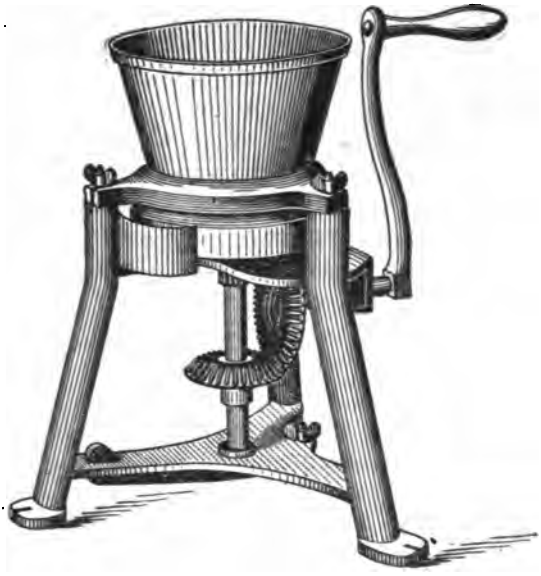

FIG. 1.—A hand-power paint mill.

A very satisfactory hand paint mill (fig. 1) can be bought for less than $10, and with such a mill the dry pigments may be mixed with oil and very satisfactory paints made directly. The claim is made, however, that many pigments require grinding under very heavy pressure to give the best results. Painters, therefore, generally prefer the use of paste pigments rather than the dry for most of their paint mixing. Besides the method of making up paints from the pigments, either dry or in paste form, with the necessary vehicle, the use of ready-mixed paints is very common, and for a small job they have an advantage, for no paint can be made properly without a large amount of grinding or stirring, and this is rather heavy work. The user of mixed paints, however, should have some method of estimating what the material he buys is really worth.

COMPOSITION OF PAINTS AND THEIR COST.

GENERAL DISCUSSION.

It would probably not be denied by anyone that a better paint can be made in a well-equipped factory than by any individual at home or in a small shop. Many ready-mixed paints are of the very best quality, but many are of poor quality, made of cheap materials, and at the same time are sold with extravagant claims and for high prices. The number of different formulæ found on the market is enormous, and no attempt will be made to give a complete or even a representative list of them. An effort will be made, however, to give a few typical formulæ of paints and the methods of calculating the cost of making paints whose composition is known. A very good rule to follow in purchasing mixed paints is to buy nothing which does not bear the name of the manufacturer. If the manufacturer's name does not appear on the label this is very good presumptive evidence that he is not particularly proud of his product. Many State laws require that the composition of paints should also be stated on the labels, and a large number of the best manufacturers do this whether their products are sold in a State requiring such labeling or not.

The most expensive paints are generally white paints or very light tints. The reason for this is that there are comparatively few white pigments which have covering power, i. e., the property of hiding the surface of the material painted. Samples of dry white lead and of dry whiting look much alike. Both are white powders and a thin layer of each appears to be practically opaque. If, however, the two pigments are mixed in oil the whiting is quite transparent, while the white lead is opaque. All of the cheaper white pigments are more or less transparent in oil and are, therefore, deficient in covering power. White lead, zinc white, sublimed white lead, zinc lead, and lithopone are practically the only white pigments which have good covering power in oil. These pigments are all rather expensive, and as they are heavy it takes quite a large amount to make a paint.

Of the dark shades, there are a number of cheaper pigments which have very good covering power. It may be quite safely stated that for a white paint that really covers, some one or more of the white pigments just enumerated must be used. For a dark brown, however, a good covering can be obtained with an iron oxid pigment, which is very much cheaper. Therefore, for such paints there is no reason for using an expensive lead or zinc pigment.

ESTIMATED COST OF WHITE PAINTS.

A vehicle for outside paint of the best quality will generally consist of from 90 to 95 per cent of linseed oil and from 10 to 5 per cent of japan drier. A good japan drier has about the same specific gravity as linseed oil, and each may be considered to weigh about 7¾ pounds to the gallon. Of course, the prices of all paint materials vary, but at the present time linseed oil sells for approximately 90 cents a gallon, and a good grade of japan can be bought for $1.60. In making up paints, the drier should be mixed with the larger portion of the oil before adding the pigment. Using the prices and weights just given for linseed oil and japan drier, the liquid portion of a paint will cost about 95 cents a gallon, or 12¼ cents a pound. White lead, both dry and in the form of paste, costs approximately 7 cents a pound, zinc white approximately 8 cents a pound, and the other white pigments which cover well will not differ very much from these two in price. A gallon of white lead paint will weigh from 21 to 22 pounds. Fourteen pounds of dry white lead and 7¼ pounds of vehicle will make a gallon of paint and at the prices quoted the cost would be about $1.87; 15 pounds of paste lead and 6¼ pounds of vehicle will make a gallon of paint, costing $1.82; 9½ pounds of white zinc and 5¾ pounds of the paint vehicle will make a gallon of zinc white paint costing about $1.46.

Of course, these prices are based on an assumed cost for the ingredients, and to make an exact estimate it would be necessary to know the exact prices of the different materials entering into the paint. Many painters insist that a paint composed entirely of white lead, linseed oil, and drier is the best. Others contend that a mixture of white lead and zinc white is the best, and still others say that a mixture of these pigments with the cheaper white pigments which have slight covering power makes a better paint than the expensive pigments alone. It is probably true that a mixture of lead and zinc is superior to either pigment by itself, and also that the addition of a small amount of so-called inert pigments (silica, whiting, barytes, china-clay, etc.) has no injurious effect on the paint and may even be beneficial. The addition of a large amount, however, of such pigments will give a paint deficient in covering power, and the addition should have the effect of cheapening the product. There is no reason why any mixed paint should cost per gallon more than a paint made entirely of white lead, oil, and the necessary drier. By ascertaining the market price of white lead and linseed oil the buyer should be able to calculate the maximum price for a mixed paint.

Two samples of ready-mixed white paints which were bought at the same time, at practically the same price, will give an illustration of the difference in price of such materials. No. 3361, a white paint, weighed 12.4 pounds to the gallon. The total paint consisted of 63 per cent pigment and 37 per cent vehicle. The pigment contained 30 per cent zinc lead, 13 per cent white lead, 7 per cent whiting, and 50 per cent barium sulphate. Assuming the value of the zinc lead to be the same as that of the white lead, 43 per cent of the pigment was worth 7 cents a pound, and assuming the value of the whiting and barium sulphate to be 1 cent a pound, 57 per cent of the pigment was worth 1 cent a pound. The average price per pound of the pigment would, therefore, be 3.58 cents. A gallon of the paint weighs 12.4 pounds, of which 63 per cent, or 7.812 pounds, is pigment; this, at 3.58 cents a pound, would cost 28 cents. Thirty-seven per cent of vehicle in the gallon of paint will weigh 4.588 pounds. In this paint it consisted of linseed oil and a cheap benzin drier costing about 11 cents a pound, or 50 cents for the vehicle. The total cost of the materials in the paint, then, would be 78 cents per gallon.

Another paint, No. 3864, weighed 14.8 pounds per gallon and consisted of 58 per cent of pigment and 42 per cent of vehicle. The pigment was 55 per cent white lead and 45 per cent zinc white. If the price of these two pigments was 8 and 7 cents, respectively, the average price of the pigment in this paint would be 7.55 cents per pound. Since the gallon of paint weighed 14.8 pounds and contained 58 per cent of pigment, a gallon contained 8.584 pounds of pigment and 6.216 pounds of vehicle. The vehicle in this case was linseed oil and a good grade of turpentine drier. The pigment in this gallon of paint would be worth 65 cents (8.584×7.55) and the vehicle 76 cents (6.216×12.25). The total cost of the materials in this paint, therefore, would be $1.41.

These two paints, as before stated, were bought at the same time and at practically the same price. The prices paid would not be indicative of their value at the present day, since they were bought several years ago, when paint materials were considerably cheaper than they are now; but it is obvious that the margin of profit was very much greater on paint No. 3861 than on No. 3864.

ESTIMATED COST OF COLORED PAINTS.

Tinted paints, at least those of light tint, consist practically of white paint with the addition of a small amount of coloring matter. The coloring materials used in tinting are not uniform, and it is not possible, therefore, to give exact directions for producing a particular shade, since the amount of color used will depend upon the individual characteristics of the particular lot on hand. In general, gray tints are made from white paints by the addition of a black pigment, such as lampblack or bone black, and sometimes a small amount of red or blue is used also. The total amount of coloring matter employed varies, but rarely amounts to as much as 5 per cent. Buff may be made by the addition of mixtures of ocher and umber; brown, by the addition of mixtures of black, red, and sometimes yellow. Yellow and cream may be made by the addition of ocher or chrome yellow; frequently for this purpose golden ocher is used, which is ordinary ocher brightened by the addition of a small amount of chrome yellow. Blue tints may be made by the addition of small amounts of Prussian blue. This is a powerful tinting pigment, and it is seldom that more than 1 per cent is required. With the white paints which contain no lead, ultramarine blue may be used instead of Prussian blue; but ultramarine blue should not be used with lead paints.

Besides the tinted white paints, bright colors are sometimes desired, especially green, for blinds, and reds for the trimmings of houses or for machinery. These paints seldom contain any large amount of the expensive lead and zinc white pigments, but consist of comparatively small quantities of coloring matter and large amounts of the cheap white pigments. For black paints there is practically only one coloring substance, namely, carbon, which, however, occurs commercially in a number of forms. The color of so-called drop or ivory black is carbon, obtained from charred bone; lampblack is carbon in the form of soot. The latter, although very pure, does not make a satisfactory black alone, the heavier forms of carbon, such as bone black or even ground charcoal, producing a better black.

In the following table is given the composition of several tinted paints, and also of bright red, bright green, and black. The composition of individual lots of paint of any of these tints or colors might vary considerably from that given, and the table is only illustrative of the materials from which these different kinds of paints may be made. An estimate of the cost of the raw materials entering into the different formulæ is also included. The total cost per gallon does not make any allowance for labor or for containers, but is based solely upon the cost of the raw materials, assuming that white lead and sublimed white lead cost 7 cents a pound, white zinc 8 cents, and the other white pigments, barium sulphate, china-clay, whiting, and asbestine, 1 cent a pound. The price of the coloring material is given separately for each paint. These prices for the raw materials are a fair approximation of the retail price at the present time. In calculating the cost of the paints per gallon it is assumed that the vehicle in all cases is the same as that described on page 15 and it is valued at 12½ cents a pound. An inspection of the table shows that there is comparatively little difference in the cost of the materials entering into these paints, with the exception of black paint, which is considerably cheaper than any of the others. The red paint is colored by an expensive color, para-red, costing 78 cents a pound; the rest of the pigment, however, is cheap, and it will be noticed that the paint weighs only 11.6 pounds per gallon, whereas some of the others weigh much more.

Composition and cost of tinted and colored paints.

Data.	Tints.						Colored paints.		
	Gray.	Buff.	Yellow.	Drab.	Blue.	Brown.	Red.	Green.	Black.
Percentage composition:									
Vehicle	43.4	43.0	45.0	41.0	43.0	49.0	57.0	34.0	65.0
White lead	....	....	13.0	....	....	12.0	....	....	....
Zinc white	21.0	21.0	25.0	21.0	22.0	24.0	2.0	....	....
Sublimed white lead	27.0	29.0	....	26.0	27.0	....	....	....	....
Barium sulphate	2.0	....	5.0	2.0	2.0	5.0	25.0	49.0	....
China-clay	5.0	....	....	4.0	4.0	....	....	....	....
Whiting	....	....	....	....	....	....	11.0	....	....
Ground slate	....	....	....	....	....	....	....	....	26.0
Asbestine	1.0	1.0	1.0	1.0	1.0	1.0	....	....	....
Color	.6	6.0	11.0	5.0	1.0	9.0	5.0	17.0	9.0
Total pigment	56.6	57.0	55.0	59.0	57.0	51.0	43.0	66.0	35.0
Nature of color	([1])	([2])	([3])	([4])	([5])	([6])	([7])	([8])	([9])
Weight in pounds per gallon:									
Total	14.7	14.8	14.1	15.2	14.8	13.4	11.6	16.4	10.0
Pigment	8.32	8.44	7.76	8.97	8.44	6.83	4.99	10.82	3.50
Vehicle	6.38	6.36	6.34	6.23	6.36	6.57	6.61	5.58	6.50
Cost per pound, dollars:									
Color	0.05	0.04	0.05	0.05	0.30	0.05	0.78	0.19	0.10
Total pigment	.065	.069	.066	.065	.070	.066	.103	.056	.033
Cost per gallon, dollars:									
Pigment	.541	.582	.512	.583	.591	.451	.514	.606	.116
Vehicle	.782	.779	.777	.763	.779	.805	.810	.684	.796
Total	1.32	1.36	1.29	1.35	1.37	1.26	1.32	1.29	.91

[1] Bone black; tuscan red; ultramarine blue.
[2] Umber and ocher.
[3] Golden ocher.
[4] Ocher and bone black.
[5] Prussian blue.
[6] Bone black; venetian red; chrome yellow.
[7] Para-red.
[8] Five-sixths chrome yellow, one-sixth Prussian blue.
[9] Carbon.

For dark shades of brown or red there is probably nothing which is as cheap as the oxid of iron pigments. These vary very much in shade, giving both browns and dull reds. A pigment that gives a very satisfactory reddish brown and contains about 40 per cent of iron oxid makes a satisfactory paint containing approximately 56 per cent pigment and 44 per cent vehicle, the vehicle being very much the same as that used in a first-class white paint. Such a paint will weigh about 13.5 pounds to the gallon, which, therefore, will contain 7.56 pounds of pigment and 5.94 pounds of vehicle. This pigment is cheap, generally costing not more than 1 or 1½ cents per pound. The pigment in a gallon of this paint, therefore, would cost approximately 10 cents, and the 5.94 pounds of vehicle about 73 cents, giving a cost of 83 cents for the gallon of paint.

An inspection of these figures shows that the expensive part of this paint is the vehicle and not the pigment. A paint of this character is a very good material to apply either to wood or iron. There are more expensive paints, however, frequently used on iron to protect it from rusting, the most popular being red lead and linseed oil. This material undoubtedly affords very good protection, but it is also expensive. A red-lead paint can not be made and kept as most other paints can. The red lead itself causes the oil to dry, and no additional drier is necessary. In fact, red lead should not be mixed until just before it is used. A paint made of 70 per cent of red lead and 30 per cent of linseed oil will weigh about 19.8 pounds to the gallon. A gallon of paint, therefore, will contain 13.86 pounds of red lead, which costs about 8 cents a pound, making the cost of the pigment in a gallon of this paint approximately $1.11. The 30 per cent of linseed oil will weigh 5.94 pounds, and a gallon of linseed oil 7.75 pounds, costing about 90 cents at the present time, or 11.5 cents a pound. The oil in the paint will cost then about 68 cents, and a gallon of red-lead paint would cost $1.79, as compared with 83 cents for a gallon of oxid of iron paint. These two paints will cover about the same area of clean iron, and while somewhat better service might be expected from the red-lead paint, it is more than twice as expensive as the iron-oxid products.

WHITEWASH.

Whitewash is the cheapest of all paints, and for certain purposes it is the best. Lime, which is the basis of whitewash, makes a very sanitary coating, and is probably to be preferred for cellars and the interior of stables and other outbuildings. The following directions for making whitewash are taken from "White Paints and Painting Materials," by W. G. Scott:

> Ordinary whitewash: This is made by slaking about 10 pounds of quicklime with 2 gallons of water.
>
> The lime is placed in a pail and the water poured over it, after which the pail is covered with an old piece of carpet or cloth and allowed to stand for about an hour. With an insufficient amount of water, the lime is "scorched" and not all converted into hydrate; on the other hand, too much water retards the slaking by lowering the heat.
>
> "Scorched" lime is generally lumpy and transparent, hence the use of the proper amount of water for slaking and an after addition of water to bring it to a brush consistency.

Factory whitewash. (*Interiors*): For walls, ceilings, posts, etc.

(1) Sixty-two pounds (1 bushel) quicklime, slake with 15 gallons water. Keep barrel covered until steam ceases to rise. Stir occasionally to prevent scorching.

(2) Two and one-half pounds rye flour, beat up in ½ gallon of cold water, then add 2 gallons of boiling water.

(3) Two and one-half pounds common rock salt, dissolve in 2½ gallons of hot water.

Mix (2) and (3), then pour into (1) and stir until all is well mixed.

This is the whitewash used in the large implement factories and recommended by the insurance companies. The above formula gives a product of perfect brush consistency.

Weatherproof whitewash. (*Exteriors*): For buildings, fences, etc.

(1) Sixty-two pounds (1 bushel) quicklime, slake with 12 gallons of hot water.

(2) Two pounds common table salt, 1 pound sulphate of zinc, dissolved in 2 gallons of boiling water.

(3) Two gallons skimmed milk.

Pour (2) into (1), then add the milk (3) and mix thoroughly.

Lighthouse whitewash: (1) Sixty-two pounds (1 bushel) quicklime, slake with 12 gallons of hot water.

(2) Twelve pounds rock salt, dissolve in 6 gallons of boiling water.

(3) Six pounds Portland cement.

Pour (2) into (1) and then add (3).

NOTE.—Alum added to a lime whitewash prevents it rubbing off. An ounce to the gallon is sufficient.

Flour paste answers the same purpose, but needs zinc sulphate as a preservative.

Molasses renders the lime more soluble and causes it to penetrate the wood or plaster surface; a pint of molasses to 5 gallons of whitewash is sufficient.

Silicate of soda solution (about 35° Baumé) in the proportion of 1 to 10 of whitewash produces a fireproof cement.

A pound of cheap bar soap dissolved in a gallon of boiling water and added to about 5 gallons of thick whitewash will give it a gloss like oil paint.

An old receipt for whitewash, issued by the Lighthouse Board of the Treasury Department, said to be very good for outdoor exposure, is as follows:

Slake half a bushel of unslaked lime with boiling water, keeping it covered during the process. Strain it and add a peck of salt, dissolved in warm water; three pounds of ground rice put in boiling water and boiled to a thin paste; half a pound of powdered Spanish whiting and a pound of clear glue, dissolved in warm water; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace; and when used, put it on as hot as possible, with painters' or whitewash brushes.

The washes which contain milk, flour, or glue are not to be advised for use in damp, interior places, owing to danger of decomposition of the organic matter. For such locations it is better to use one of the formulæ containing none of these ingredients. Whitewash is applied with a broad whitewash brush and is spread lightly over the surface, no attempt being made to brush it in as is the case with an oil paint.

CALCIMINE.

Cold water paints or calcimine have as their basis whiting or carbonate of lime instead of caustic lime, as in whitewash. This material itself does not adhere, and it is necessary to use a binder of some kind, generally glue or casein. Scott also gives the following directions for making calcimine:

Ordinary white stock. (*Calcimine*): (1) Sixteen pounds dry Paris white (whiting) mixed until free of lumps, with 1 gallon boiling water.

(2) One-half pound white sizing glue; soak 4 hours in one-eighth gallon cold water. Dissolve on a water-bath (gluepot) and pour into (1).

The above recipe makes about 2 gallons of stock, weighing 12¾ pounds per gallon. It is of proper brush consistency and may be used at once, but is better after standing half an hour. Any tint may be given the white stock by stirring the desired dry color in a little water and adding sufficient liquid color to the base.

The following data in regard to the covering capacity and time of applying was obtained as an average of several years' work from shop records:

One gallon covers on plaster=270 square feet.

One gallon covers on brick=180 square feet.

One gallon covers on wood=225 square feet.

A man in 1 hour, using a 5-inch brush, will coat the following amount of surface:

Rough walls=22 square yards (198 sq. ft.).

Smooth walls=38 square yards (342 sq. ft.).

Brick walls=20 square yards (180 sq. ft.).

Flat surface (bench or floor)=40 square yards.

Ceiling (with stepladder)=25 square yards.

Damp-proof calcimine. (*White stock*): For plastered walls. (1) Sixteen pounds Paris white or extra gilder's whiting, 1 gallon boiling water.

(2) One-half pound white sizing glue, soak 4 hours in one-half gallon cold water, then dissolve on a water bath.

(3) One-fourth pound phosphate of soda, dissolve in one-eighth gallon boiling water.

Mix (3) with (1), then add (2).

If a thick white stock is wanted, use half a gallon of water with the 16 pounds of Paris white instead of one gallon. For tinting, use colors that are not affected by lime, namely, yellow ochers, sienna, umbers, Venetian red, para-red, maroon oxid, ultramarine blue, ultramarine green, chromium oxid, bone black, etc.

If lampblack is used for tinting, it must be stirred up in hot water containing a little soap or in cold water containing a little borax, the alkali overcoming the greasy nature of the lampblack.

PRECAUTIONS TO BE OBSERVED IN PAINTING.

Do not use any paints containing compounds of lead about stables or outbuildings where the fumes from decaying organic matter occur, since these gases are likely to darken the lead paints. Do not use with lead compounds any pigments which may liberate compounds of sulphur. For example, ultramarine blue which contains sulphur in a form in which it may be set free is a beautiful and very permanent blue and may be used with zinc white, but should not be used with white lead or any other lead pigments. Prussian blue, on the contrary, does not contain sulphur and may be used with lead pigments.

Remember that turpentine and benzin are very inflammable, and especial precautions should be taken not to bring paint containing these substances near any light or open fire.

Many pigments are poisonous, and the workman should be particularly careful to remove all paint stains from the skin, and not under any circumstances allow any of it to get into his mouth. A man should not eat in the same clothes in which he has been painting, and before eating should not only change his clothes but wash all paint stains from his skin. It is not advisable to use turpentine or benzin in removing paint stains from the hands, but by oiling thoroughly with linseed oil, or, in fact, with any fatty oil, and then thoroughly washing with soap, the paint may be removed, provided it has not been allowed to dry too thoroughly on the hands.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 475.

ICE HOUSES.

BY

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WASHINGTON:
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1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 18, 1911.

Sir: I have the honor to transmit herewith a paper entitled "Ice Houses," prepared by Prof. L. C. Corbett, Horticulturist of this Bureau, and recommend that it be published as a Farmers' Bulletin. It treats of the advantages of a supply of ice for farm use and gives directions for harvesting ice and constructing ice houses.

This paper has been prepared in response to numerous inquiries for information on the subject. It is believed that its publication will encourage producers to give more attention to the marketing of perishable products, as well as to provide their tables with home products which can not be kept without ice.

Very respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—697.

ICE HOUSES.

INTRODUCTION.

The great variety of uses to which ice is now put in the economies of living is sufficient reason for a brief discussion of the principles of ice preservation and the construction of ice houses. In many parts of the country the harvesting of ice is an important industry. Immense houses are constructed and equipped with elaborate power devices for elevating ice. These houses are are only temporary storage quarters, however, as this great harvest of millions of tons is made to meet the wants of the sweltering cities during the heated months.

As the demand for ice in the cities increases with the rise in temperature, cars and ships are pressed into service to transport the contents of these great storehouses. Before the manufacture of artificial ice was a commercial possibility the storage and distribution of natural ice was the only means of relief for the denizens of the city from the summer heat. Downing in his essay on ice houses says that millions of dollars worth of ice has been shipped from Boston alone in the last eight years, a considerable part of this trade being with foreign countries. While at the present time most inland towns of the South rely upon the home manufacture of ice, coast cities still receive a part of their annual supply from the natural ice fields of the North, where it has been stored during the winter season.

It is not with the ice crop as a source of direct revenue that this bulletin treats, but with ice as a factor in the economies and comforts of the country home.

An ample supply of ice is of greater economic importance in the country home than in the city residence. City people can purchase perishable supplies as needed, but the remoteness of country homes from markets often renders it necessary to use canned, corned, or smoked meat products during the season of the year when the table should be supplied with fresh meats. Not only is ice appreciated because of its use in the preservation of fresh meats, butter, and other table supplies, but the production of high-grade domestic dairy products is almost impossible without it. Many markets to which milk is now shipped demand that it be cooled before shipment to a degree not attainable without the use of ice.

Ice is one of those luxuries which in many sections of the country can be had for the gathering. The cost of harvesting and storing it is not great as compared with the comfort that it brings.

THE SOURCE OF THE ICE SUPPLY.

The source of the ice supply will vary with local conditions. In many sections lakes, rivers, or large streams will afford a supply of suitable ice without special plan or preparation on the part of man. In other instances, where such natural sources are not easily accessible, small streams or even the water from a spring can be stored in an excavation or by means of a dam, so as to afford sufficient water surface to provide the desired ice supply. The harvest area or surface will depend upon the tonnage to be stored and the normal thickness of the ice in the locality. In central New York the normal ice supply ranges from 8 to 12 inches in thickness, while in eastern Virginia 4 to 6 inches is as great a thickness as can usually be counted upon.

The stream or pond from which the supply of ice is taken should be fed from a source free from contamination or pollution. If the stream is so sluggish that water weeds thrive in it, all vegetation must be removed to prevent its freezing in the ice. Decaying vegetable matter frozen in ice is very objectionable, because as the ice melts this matter is deposited in the ice box or refrigerator, rendering it unnecessarily filthy and dangerous to health.

Ponds in which green spawn or algæ grow profusely can be rid of these pests by the use of copper sulphate. The crystals can be placed in a cloth sack, which is hung to a pole and trailed through the water until the salts are dissolved. One or two treatments of the sulphate during the season at the rate of 1 pound to 100,000 gallons of water will be sufficient to keep down such growth and make the water clear and pure. It is impossible to have pure ice unless the pond or stream is clean and the water is free from contamination.

THE PRINCIPLES OF ICE STORAGE.

In order to keep so perishable a commodity as ice it is necessary in the construction of a storage structure to consider carefully those physical and mechanical principles which underlie its preservation. (1) To keep well, ice must have a minimum of surface exposed to the air or to the packing material. This is most easily accomplished by piling the ice in the form of a cube. A mass of ice 12 by 12 by 12 feet exposes less surface than the same tonnage piled in any form less nearly that of a cube or of a globe. (2) The keeping of good ice depends upon the completeness of its insulation, whereby it is protected from external influences, such as heat and air. (3) Drainage is important because the lack of it interferes with the insulation. (4) The ice itself must be packed so as to prevent as completely as possible the circulation of air through the mass. The more nearly the mass of ice approaches that of a solid cube, both in shape and texture, the easier, with good drainage and insulation, will be the keeping problem. The keeping of ice, then, depends upon the shape of the mass, its insulation, its drainage, and its solidity.

THE ICE HARVEST.

The ease and rapidity with which ice can be gathered depend upon the condition and location of the field and the character of the tools and conveniences at hand for doing the work.

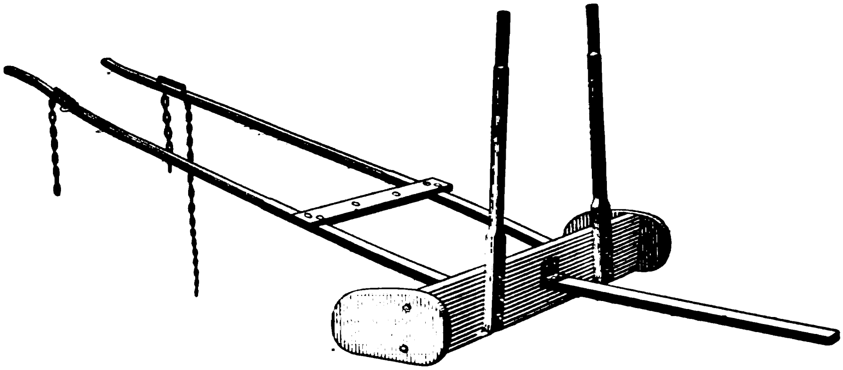

FIG. 1.—A horse-power scraper for removing snow from an ice field.

CLEARING THE ICE FIELD.

If the ice field is covered with snow the formation of ice will be retarded, as the snow acts as a blanket and raises the temperature, thus retarding the ice formation. If the ice sheet is sufficiently thick and snow falls upon it, the snow must be removed before harvesting can proceed; or if, on the other hand, it is desirable to increase the thickness of the ice after the snow falls, the field may be flooded and the snow saturated with water, which is allowed to freeze, thus adding a layer of snow ice. Flooding on small fields may be accomplished in either of two ways: (1) By "overflowing," which consists merely in conducting water to the field, or by piercing the ice field here and there with a bar or auger, to allow the water to force itself to the surface and gradually to saturate the snow.

Snow may be removed from small fields, when necessary, by means of shovels, but upon large fields it will be economical to use horse-power scrapers. A simple plank scraper is shown in figure 1.

HARVESTING THIN AND THICK ICE.

Ice not over 4 inches thick and ice from 6 to 15 inches in thickness require very different methods of procedure. The thin ice in general will be broken into more or less regular cakes, which will be loaded as best they may into sleds or wagons and hauled to the storehouse, where they may be arranged in layers and adjusted as closely as possible, the spaces between the cakes being filled with crushed ice or snow in such a manner as to cause the whole mass to freeze into

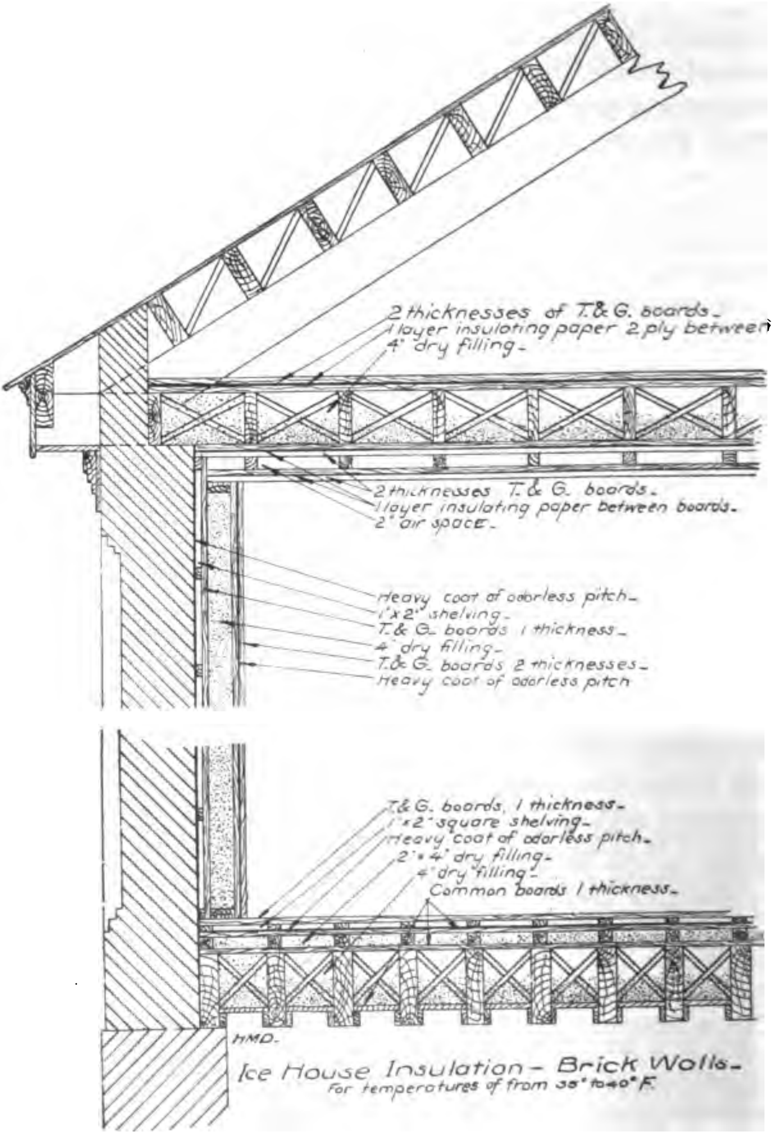
2 thicknesses of T.& G. boards.
1 layer insulating paper 2 ply between.
4" dry filling.
2 thicknesses T.& G. boards.
1 layer insulating paper between boards.
2" air space.
Heavy coat of odorless pitch.
1"x2" shelving.
T.& G. boards 1 thickness.
4" dry filling.
T.& G. boards 2 thicknesses.
Heavy coat of odorless pitch
T.& G. boards, 1 thickness.
1"x2" square shelving.
Heavy coat of odorless pitch.
2"x4" dry filling.
4" dry filling.
Common boards 1 thickness.
HMD.
Ice House Insulation – Brick Walls.
For temperatures of from 35° to 40° F.

FIG. 2.—Diagram showing the insulation of an ice house for storing ice without sawdust or shavings.

as nearly a solid block of ice as possible. It is more difficult to store and keep ice of this character than that harvested in regular cakes. Several factors combine to make the construction of a house for the preservation of such a supply more exacting than if built for keeping a better grade. Thin ice is characteristic of the southern limits of the storage of natural ice. The supply is more or less uncertain. The storage period is long. The irregular form of the cakes makes it difficult to pack the ice so as to prevent air spaces, which may form air passages and cause rapid loss. Irregular blocks and cakes are less easily insulated than regular cakes of uniform size and thickness. If the mass is stored in a building without packing material about it, insulation must be provided for in the construction of the house. The walls must be thick, well packed with mill shavings or dry sawdust, and tightly boarded on both sides of the packing material. A space of 15 inches between the walls, tightly packed with good insulating material, is none too much. An added safeguard would be to double both the outside and inside walls. The type of wall construction suggested in figure 2 would be suitable for a house intended for the storage of ice of this character.

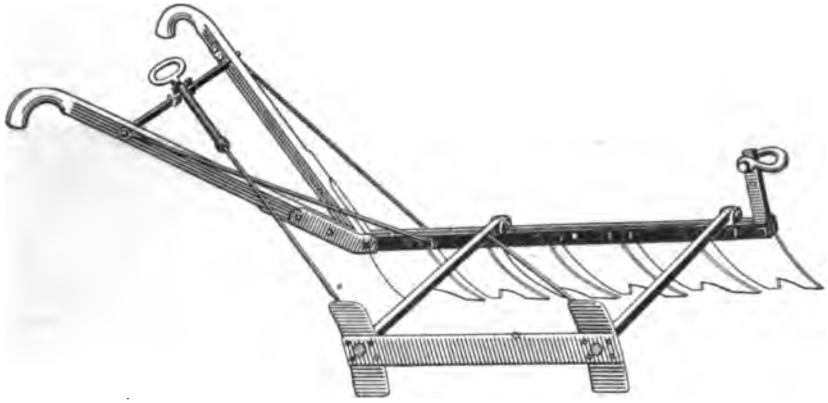

FIG. 3.—An ice plow with a guide gauge.

Harvesting ice from 6 to 15 or more inches in thickness permits the use of tools and implements that find no place in harvesting thin ice. The field may be laid off so as to cut the cakes to standard dimensions of 22 by 22 inches or 22 by 32 inches. Oblong cakes have some advantages over square ones, as they can be lapped so as to break joints as they are stored, thus reducing the possibility of the formation of air passages in the ice heap.

In order to obtain cakes square or rectangular in form a square made from light strips of boards with straight edges may be used. A square with sides 12 to 16 feet long will serve the purpose nicely. Draw a line across the ice field parallel with each side of the square and with a hand marker or with a saw accurately follow this line. By the use of a plow with a gauge attached, such as is shown in figure 3, the field can be cut into parallel bands or ribbons. If the harvest is an extensive one and the water is of considerable depth, after the field is plowed at right angles to the first plowing the ice may be barred off in large masses or strips and floated to the shore or loading place, where it can easily be broken by an ice spud or bar into cakes of the dimensions outlined by the plow. The use of a plow is not confined to large fields or to ice that will bear the weight of a horse. In fact, ice fields on bodies of water too shallow to permit the use of a saw can be harvested by means of the plow by attaching to it a light wire cable or rope and operating it from the bank by horse power.

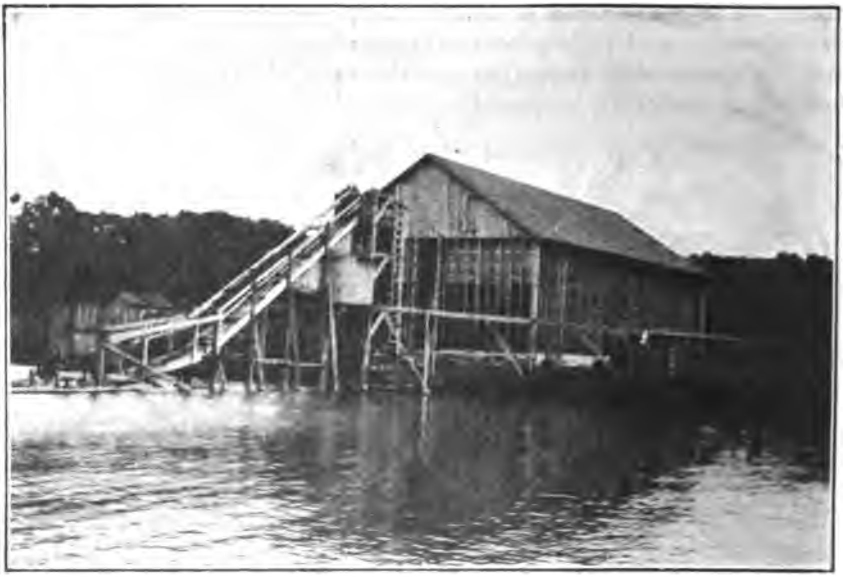

FIG. 4.—An ice house equipped with a mechanical hoist for filling.

On fields where ice is stored commercially the cakes are floated in large areas until near the channel, then barred off and carried by hoisting machines to the storage house, as suggested in figure 4. On small fields, where the quantity stored is 50 tons or less, the cakes are cut or barred off, floated to the loading platform, and placed upon it by hand or by horse power. The extent to which labor-saving devices may be introduced is measured by the cost of labor, the extent of the harvest, or the dispatch desired.

FLOE ICE.

Under certain conditions the only practicable way of obtaining a supply of natural ice is to catch it as it is going out in the spring. When the snow melts and the spring rains come on the ice at the headwaters of streams breaks up and is carried down in large masses, which can be caught at considerable distances from the localities where it was formed. In this way ice can be obtained at small cost. In the early days many plantations along the Potomac harvested an annual supply of ice of this character and stored it for the most part in pits similar to that shown in figure 5. Those fortunate enough to live conveniently near large streams may often obtain their ice supply in this way.

ICE MANUFACTURED IN METAL CANS.

In some localities none of the sources of natural ice will be available. Under such conditions ice may be manufactured by using cans made of heavy galvanized iron and provided with a heavy band-iron or wire reenforcement around the top. Any tinsmith can make such cans. The cans should be of the dimensions of a standard cake of ice; that is, 22 inches square at the top, the bottom being somewhat smaller, so as to make the sides of the can slightly flaring. As soon as settled cold weather comes arrange the cans on a level plat of ground or on a level platform near the well or other water supply. Fill the cans with clear, fresh water, and when a sufficient thickness of ice has formed to permit them to be turned over, even if the shell of ice is not more than 1½ or 2 inches thick, pour a quart or two of boiling water over each upturned can to loosen it from the shell of ice. This will give a hollow shell of ice about 2 inches thick on the bottom, which was formerly the surface of the water in the can, 1½ inches thick on the sides, and with only a thin shell on the top, which was at the bottom of the can. Break the thin shell of ice over the top and remove all but about 2 inches of the water in the cavity. Place the shell of ice in an exposed but well-shaded situation, and as rapidly as the water in the shell freezes add a few quarts at a time until the entire cavity is filled and a solid block of ice is produced. In this way, with 15 to 25 cans the necessary supply for a farm can be secured at small cost in a few days, the time depending, of course, upon the weather conditions and the number

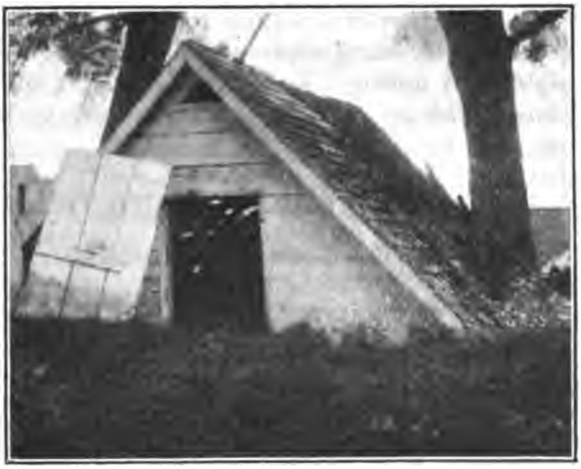

FIG. 5.—Superstructure of a pit for storing ice.

of cans in operation. If the cans are carefully handled they should last several years. The ice obtained in this way will be pure—free from vegetable growth, which sometimes damages pond and river ice. Because of its superior quality such ice will justify the construction of a building which will permit its being stored without the use of sawdust or shavings. A building constructed after the plan suggested in figure 2 will meet the requirements.

COMBINATION OF NATURAL AND ARTIFICIAL MEANS OF OBTAINING ICE.

The home ice supply is sometimes obtained by using a combination of natural and artificial means. Where an elevated water tank is at one's command, a line of pipe can be carried to perforated pipes placed on the ceiling of the ice house and during freezing weather the pressure from the tank can be used to carry water through the perforated pipes to be sprayed into the storage chamber as long as freezing continues. By careful use of this plan on cold nights and during freezing days a supply of ice can be built up in place. The protection of such a supply is the same as that of ice cut and stored in the usual manner.

TYPES OF ICE HOUSES AND THEIR ADVANTAGES.

Since ice at best is a highly perishable product, requiring special equipment for its preservation, such natural advantages as are offered by shade and exposure should be taken advantage of in locating an ice house. A shady situation with a northern exposure has a decided advantage as a location for such a building.

In general design ice houses are of three types: (1) Those built entirely above ground; (2) those built partly above and partly under ground; and (3) those of the cellar type, built entirely below ground. The aboveground structure is by far the most common of these types.

The advantages and disadvantages of these three types may be briefly stated as follows. Aboveground houses can, as a rule, be more economically constructed than either of the other designs. Excavations are expensive to make and difficult to insulate and drain properly. Insulation and drainage are two of the most important factors in the preservation of ice. It is true that the temperature of the earth varies less than that of the air, but the fact that the temperature of the earth at 6 or 8 feet below the surface remains at or about 55° F. the year around makes it quite as important to protect the stored ice against the earth heat as against the heated air. It is more difficult to remove ice as needed during the season from pits than from structures above ground. Slight advantages are apparent at harvest time in favor of the cellar or the half-sunken types of house, and under some circumstances they will be preferred to the other type.

CONSTRUCTION OF ICE HOUSES.

As has been explained, the length of time ice may be kept depends upon the character of insulation provided. This will naturally vary with the location of the ice house and the method of construction. Another important factor will be the cost of construction.

The simplest type of ice preservation consists in stacking the cakes in a compact mass on a well-drained site, as well protected as possible by natural or artificial barriers from sun and wind, and covering the mass with sawdust, shavings, fodder, marsh hay, or any other good insulating material. Such a crude method is not to be recommended except as a temporary makeshift for ice which is to be used early in the season.

INEXPENSIVE ICE HOUSES.

An inexpensive ice house which will give good satisfaction in localities on or north of the isotherm of New York City can be constructed as follows: As a site for the structure choose a well-sheltered location convenient to the place where the bulk of the ice will be used during the season. If the area is not well drained naturally, grade the surface so that no surface water can ever flow into or through the building and so that the water from the melting of the ice will be quickly disposed of. In some instances it may be necessary to provide tile drains laid 15 or 18 inches below the surface to care for this water.

Having properly provided against water, both from without and from within the ice house, set a line of squared or flattened poles 4 feet apart, so as to form a square of the dimensions desired. The height of the poles should be the same as the length of the side of the square, if the greatest economy of space and the best keeping conditions for the ice are desired, i. e., a building 14 feet square should be 14 feet high. A house of this size will provide storage for a cube of ice 11 by 11 by 11 feet, which, without allowance for voids, is equivalent to about 38 tons. (A cubic foot of ice weighs approximately 58 pounds, and 1 ton of ice occupies nearly 35 cubic feet.) To complete the ice house, cut the posts to a uniform height and nail a double 2 by 4 inch or 2 by 6 inch plate on top of them. The sides may be inclosed by boarding both inside and outside with rough lumber. To give a neat outside appearance the outside boards may be planed and ship-lapped, or ship-lap siding may be placed over the rough sheathing. The space between the two board walls may or may not be packed with shavings or sawdust. If packed, the packing material should be perfectly dry. The roof may be either a simple even-span one-third pitch roof, with the gables boarded up, or a hip roof.

In order that the house may be filled without unnecessary labor a continuous door should be provided in the middle of one end. The door should be made in two or three sections, and as the house is filled loose planks of proper length should be at hand to place across the opening of the door to hold the packing material in place as the heap of ice grows in height.

The ice must be placed on a bed of sawdust, shavings, or other packing material at least 15 inches deep, and the rick of ice should not approach the side walls closer than 15 or 18 inches, the intervening space being filled with packing material and thoroughly rammed.

MASONRY ICE HOUSES.

Instead of the cheap, temporary construction just described, ice houses of a permanent nature can be built from brick, stone, or concrete. In these, as in frame-constructed houses, the mass of ice should approach as closely as possible a cube in form. If the masonry house is to be used in the same manner as the temporary house no inside lining will be necessary. The packing used about the mass of ice may be allowed to come in direct contact with the wall. A 13-inch brick wall or a 12-inch concrete wall will provide the necessary strength. The masonry walls are not as good nonconductors as timber walls. It will therefore be necessary for the protection of the ice to rely on the packing material rather than on the wall itself. If the house is to be used for storing ice without the use of sawdust or shavings the construction indicated in figure 2 must be followed. The lining must be as complete on the floor and ceiling as on the side walls in order to provide safe insulation.

Masonry houses may be constructed entirely above ground or partly below the surface, as convenience or necessity may dictate.

RELATION OF THE ICE SUPPLY TO FRUIT STORAGE.

In order that fruits may be held for long periods in storage it is necessary that a uniform low temperature be maintained in the storeroom. With many products a uniform temperature is of more importance than a low temperature. With apples, which is the crop usually held in storage, it is desirable that the fruit reach an advanced state of maturity upon the tree, but that the ripening process be checked immediately when the fruit is placed in storage. This sudden check can not be effected in ordinary storage at picking time. It is therefore necessary that the storage house be provided with means for reducing the temperature to the required point and holding it there until natural conditions permit the introduction of cold air from the outside.

Several systems have been used for accomplishing this result. The simplest is to build the ice house as a two-story structure and to store the ice above and the fruit below. The ice may be stored at harvest time in an ice house or in an ice chamber arranged over the room in

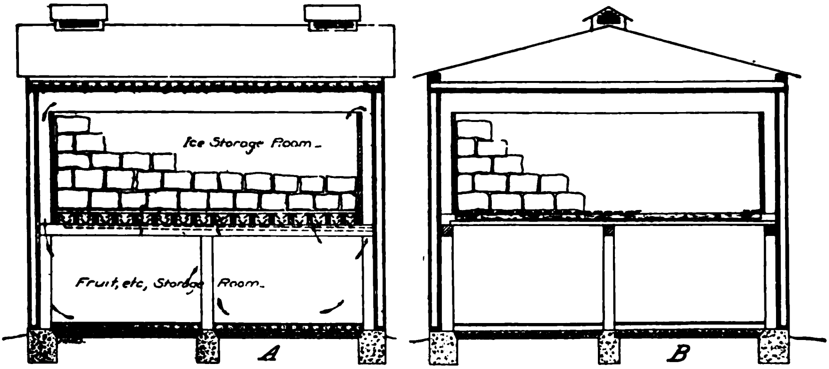

FIG. 6.—Diagrams showing cross sections of a building planned for storing ice above and fruit below: *A*, Longitudinal section; *B*, transverse section.

which the fruit is to be held, or the place may be simply a temporary storeroom to which the ice is transferred at the time the fruit is stored. Both these plans have been followed, but the one to be used in any particular instance will depend upon the cost of handling the ice and the certainty of the fruit harvest.

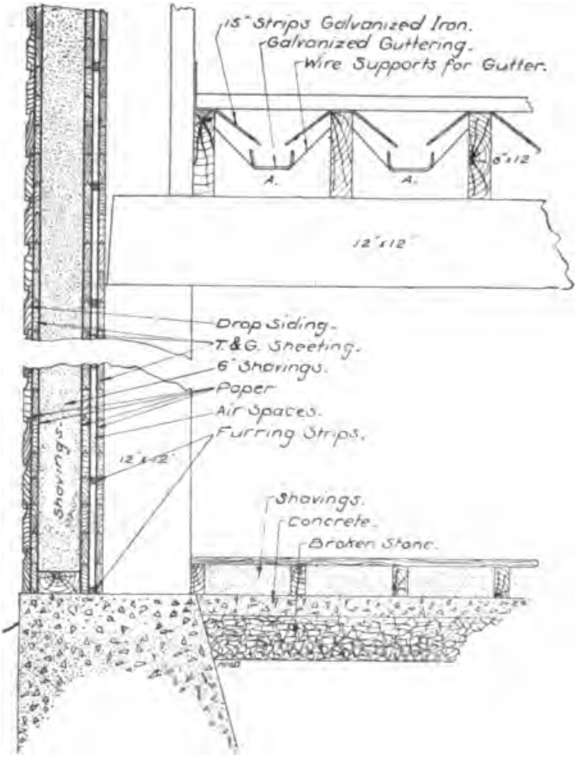

FIG. 7.—Diagrams showing the wall construction and slat floor used in the building shown in figure 6.

The general principles involved in the construction of such a house hold for both plans. Where the structure is for combined ice and fruit storage the ice chamber will of necessity be much larger than when ice is used merely to lower the temperature of the house at harvest time. The details of construction shown in figure 6 may be so modified as to adapt the building for either use. If the object is especially that of fruit storage, the ice chamber may be so reduced as to serve merely as a bunker in which to place several tons of ice at a time, to be replaced as needed. The detail of figure 7 shows a slat floor built of 2 by 4 inch Georgia pine supported on 2 by 12 inch or 3 by 12 inch joists, as needs may require. The joists are protected by a cap of galvanized metal 15 inches wide tacked to and formed over the top of the joists prior to laying the slat floor, so that the drip from each metal cap may be caught by the line of gutter (fig. 7, *A*) which is suspended between the joists. This is one of the simplest types of floor construction possible for this style of structure.

COMBINED ICE HOUSE AND DAIRY.

Even where for convenience and economy it is desirable to have the dairy under the same roof as the ice house, it is not satisfactory to attempt to combine the ice storage with a cold store. When it is necessary to use ice for chilling milk or other dairy products it is better to remove the ice from the ice house or compartment and place it in a specially constructed ice box or refrigerator rather than to attempt to maintain a cold room by storing the ice about and in contact with it. The chief argument against the combined arrangement is that it prevents the storage of ice in a solid mass. As a result the waste is much greater. Again, the requirements of the storage room and the refrigerator vary from time to time. Advantage can be taken of these fluctuation to husband the ice supply when

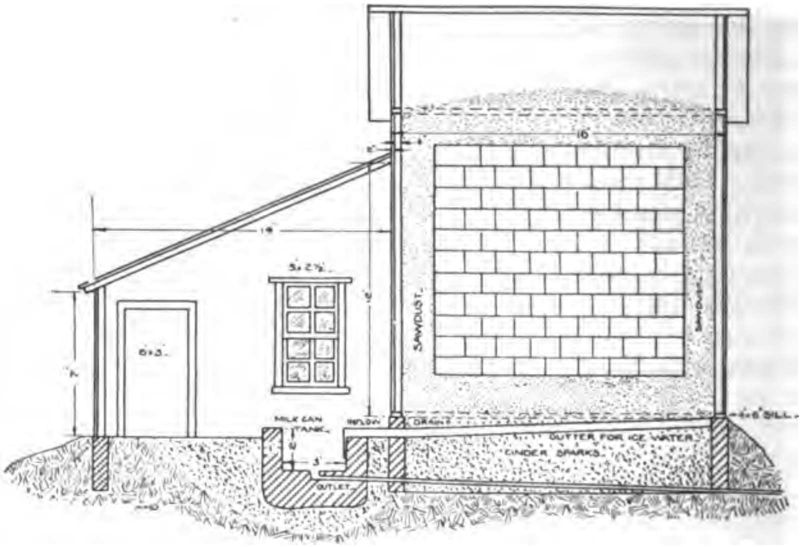

FIG. 8.—Longitudinal section of a combined ice house and dairy.

the two are separate. There are decided advantages in having the ice supply convenient to the dairy house or refrigerator, but it is poor economy to build the refrigerator or cold store inside the ice storage. The arrangement suggested in figures 8 and 9 is to be preferred.[1]

COMBINED ICE HOUSE AND REFRIGERATION PLANT FOR THE STORAGE OF FARM PRODUCTS.

Where an abundant supply of natural ice can be harvested annually it will be a simple matter to maintain high-class refrigeration by installing a brine circulating system. The principle on which this patented system works is the same as mechanical refrigeration, except that the cold is secured through a freezing mixture of ice and salt in a tank in which the primary coils are located, as shown at *B* in figure 10. As the brine in these coils becomes chilled it passes out through the bottom of the coils and slowly flows through the coils marked *C*, which are located in the cooling room. The heat of this room is absorbed by these chilled pipes and as the brine warms up it passes out and up into the primary coils, and in this way a continuous circulation is maintained between the two pipe systems.

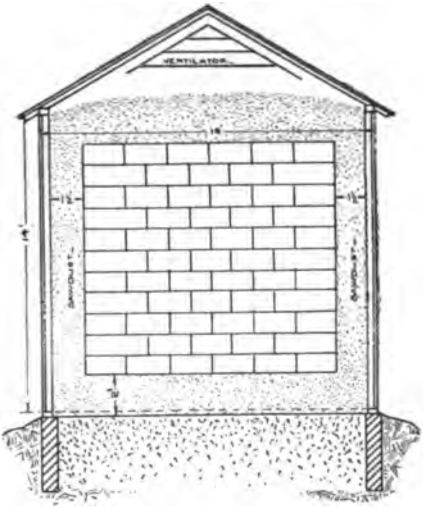

FIG. 9.—Transverse section of a combined ice house and dairy.

For convenience the ice house can be made a part of the structure, so that the ice can be elevated above the storage chamber and directly into the crusher, which can be located in the attic above the primary coils indicated at *B*. As the drawing shows, the space above the cooling room might be utilized as a farm shop or for a cooperage if one were to be installed in connection with an apple orchard. It would not be advisable to attempt to install this system without having an experienced engineer calculate the piping necessary for any given storage room as well as the cooling tank. The question of insulation is also a very important one and should be carefully specified.

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[1] For more detailed information concerning the storage of butter, see Bulletin 84, and for the storage of cheese, see Bulletin 83, both of the Bureau of Animal Industry, United States Department of Agriculture.

This construction is adapted to small or to very extensive plants. The Department of Agriculture uses this system in a plant which has been installed at the Arlington Experimental Farm. The cooling room in this case is 28 by 30 feet with 8-foot ceilings. Sufficient space is thereby provided to store 800 barrels of apples.[1]

THE CONSTRUCTION OF A REFRIGERATOR.

The construction of a farm refrigerator large enough to meet the requirements of a well-equipped farm for the storage of eggs, butter, and fresh meat and for chilling or precooling fruits in small quantities is shown in figure 11. This refrigerator can be constructed in a cellar, in the lean-to of an ice house, or in any other farm building where convenient and suitable protection can be provided. If none of these alternatives is possible, the refrigerator may be constructed as an independent building. If built as a separate structure, the same care in the choice of a site should be exercised as in choosing the location of an ice house. The construction is shown in detail in figure 11. The essential feature is a well-insulated room containing an ice rack, drip pan, and drain. This refrigerator is 8 by 10 feet and has a floor space 6 by 8 feet available for the storage of produce.

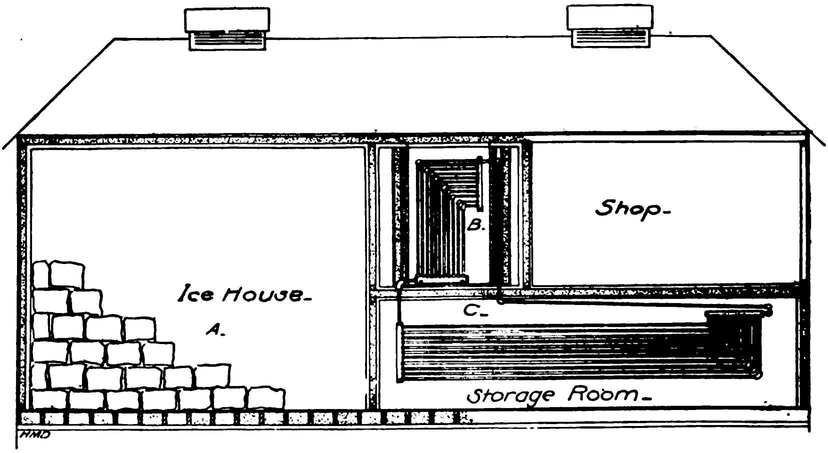

FIG. 10.—Diagram showing a combined ice house and cold-storage plant.

Such an arrangement will require about 100 tons of ice during the year, but it can be used to hold eggs and butter over the season of abundant production. A supply of fresh meat can be kept by such means in localities where distributing wagons are not run, and even where a local supply is available the producer can arrange to supply his table at wholesale rather than retail prices by killing his own sheep, pigs, or veal. Instances are known where an equipment of this sort has paid for itself in a single season through the advance secured by holding the egg output for only 60 days. Dealers purchase and store eggs while they are most abundant and cheapest and dispose of them during the season of less abundant production at an advanced price. A well-constructed and well-handled refrigerator of this kind on the farm will enable the producer to keep this profit at home.

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[1] For further information on the storing of apples, see Bulletin 48, Bureau of Plant Industry, United States Department of Agriculture.

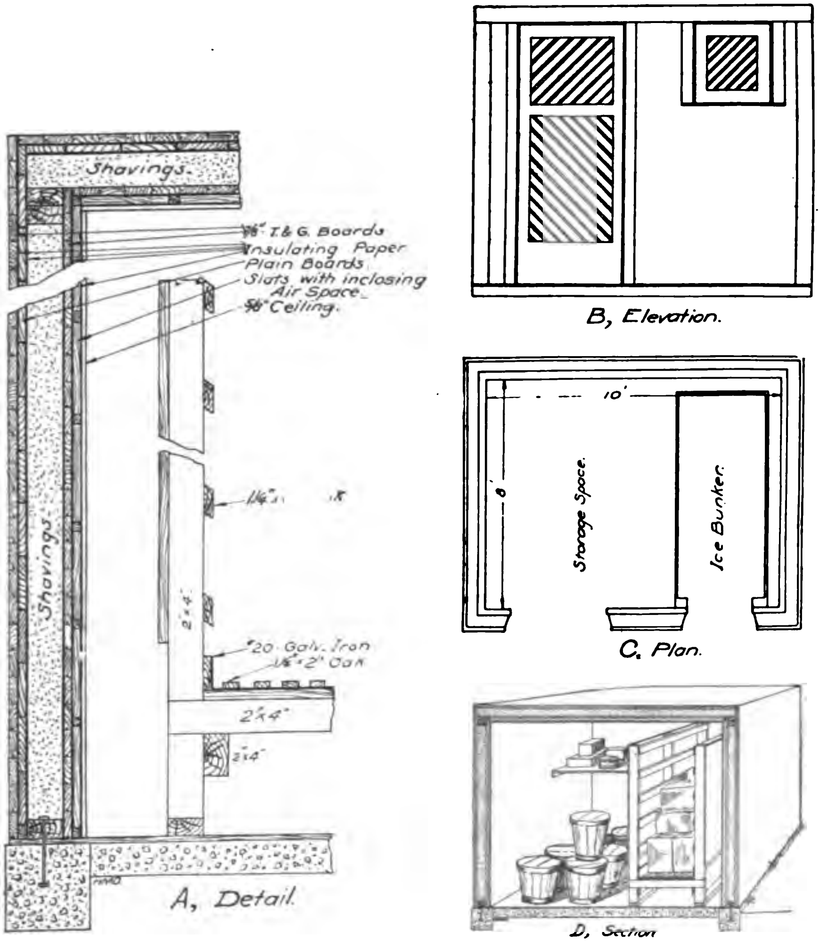

Fig. 11.—Diagrams showing cross section and details of construction of a farm refrigerator: *A*, Detail of wall construction and ice bunker; *B*, front elevation; *C*, floor plan; *D*, sectional view.

THE CONSTRUCTION OF AN ICE CHEST.

Where a less expensive cooler is desired an ice chest will be found to serve a useful purpose. Such a chest can be made from two boxes, one 12 inches longer and wider than the other and 6 inches deeper. If the inner box is 2 feet wide, 2 feet deep, and 3 feet long, the outer box should be 3 feet wide, 4 feet long, and 30 inches deep. The inner box, which should be made of matched white pine or cypress, should be lined with zinc and provided with a drip pipe in the bottom near one end and a metal grating 12 inches from that end, so as to make a cage in which to store a block of ice. A layer of 6 inches of cork dust or dry white-pine shavings should be placed in the bottom of the larger box after it has been lined with waterproof building paper. Place the smaller box on the layer of insulation, making provision for the drain, and then pack the same insulating material tightly in the space between the outer and the inner box. Fit a board over the packing between the boxes so as to cover the edges of both. Then hinge a thick well-insulated cover to the outer box, which should fit tightly and be large enough to cover the entire top of the chest. The joints can be made tight by weather strips and felt. The cover should be provided with a counter weight and a good ice-chest hasp to hold it in place.

CONCLUSION.

An ample supply of ice on the farm is of great economic importance. The work of harvesting and storing is done at a season when it will cost very little, as help and teams are usually less remuneratively employed during the winter than during the summer months. The cost of constructing ice houses and refrigerators is small in comparison with the economic returns and the comfort which they afford. Ice is of greater economic importance in the country than in the city, yet few who have the opportunity avail themselves of this luxury.

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